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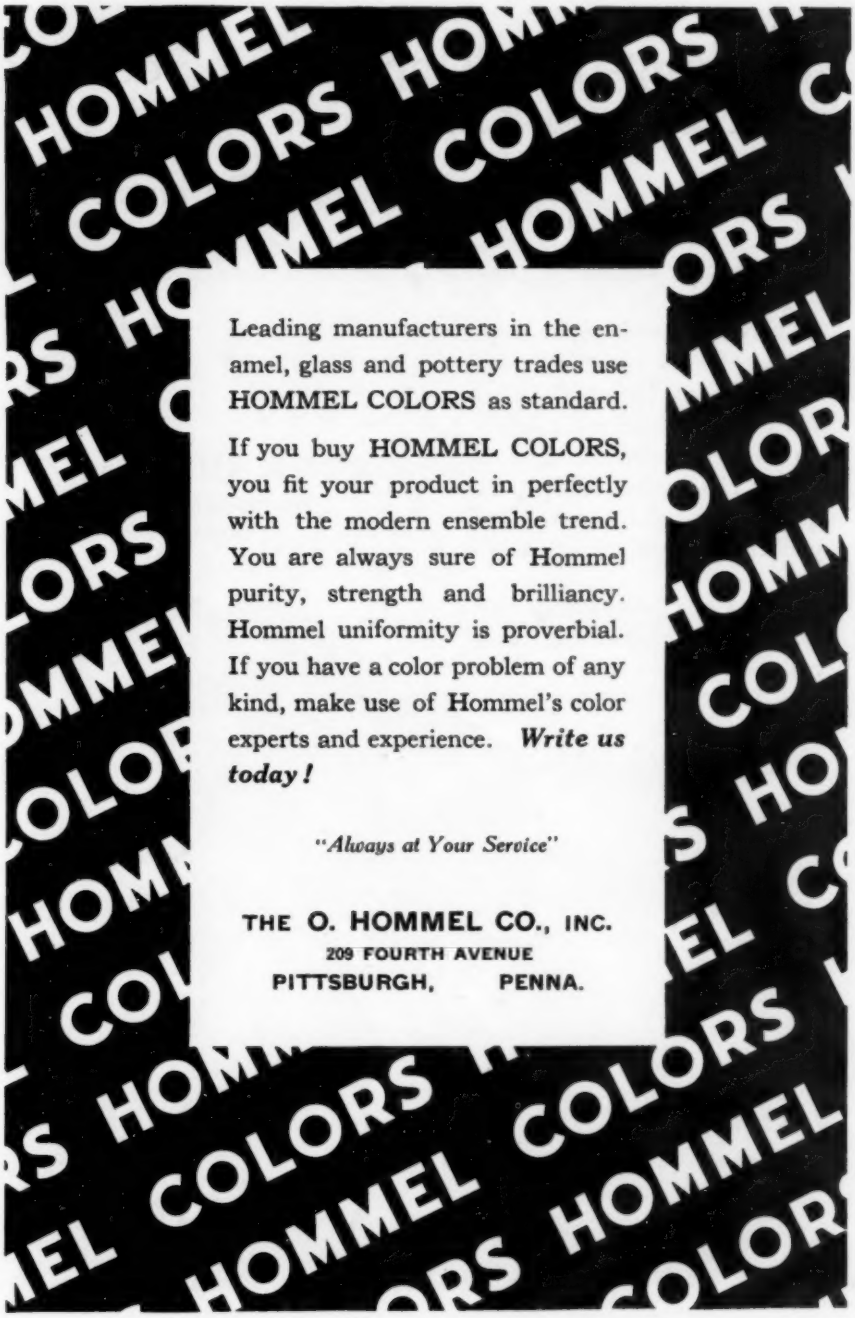
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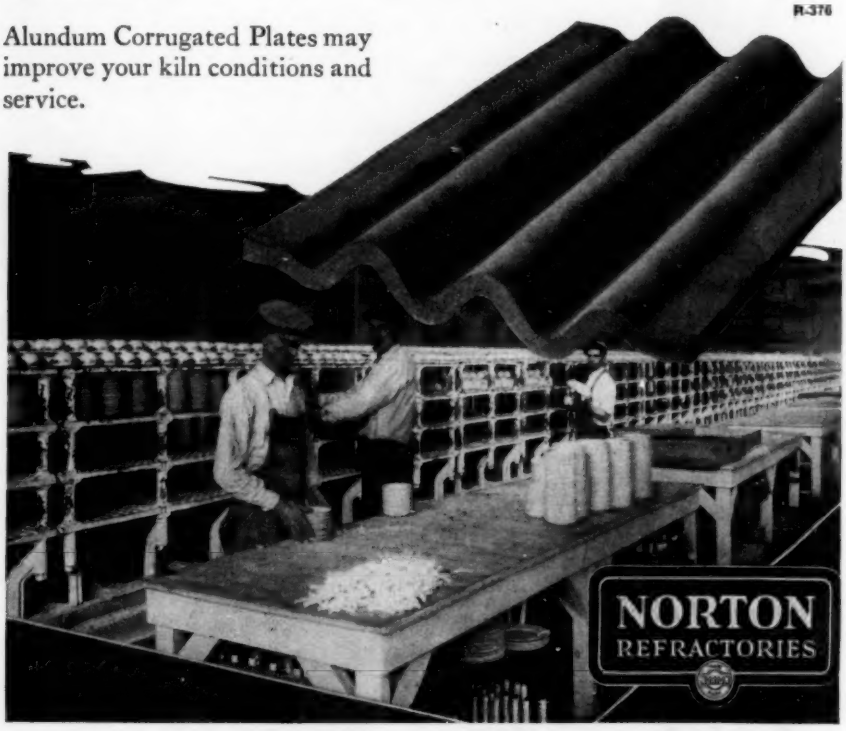

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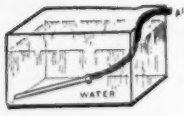

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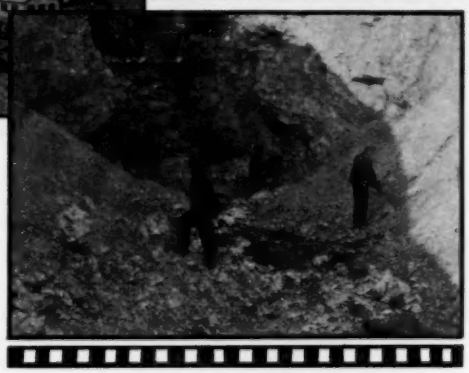

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DENSITY FACTORS FOR SODA-LIME GLASSES[1]

By S. R. Scholes

ABSTRACT

Density factors based on oxides are criticized. A series of glasses are analyzed, compositions calculated in terms of $Na_2O \cdot 2SiO_2$, $CaO \cdot SiO_2$, $MgO \cdot SiO_2$, SiO_2, and Al_2O_3. Factors for the three assumed compounds are calculated from three of the glasses, factors for SiO_2 and Al_2O_3 as given by other investigators adopted, and the factors applied to the calculation of densities for the series of glasses. The results show close agreement with measured densities for six glasses analyzed and one described in the literature.

Introduction

Following the investigations of the Jena group of glass technologists, it has been assumed that the effects of the various glass-forming oxides upon any specific physical property are additive. Thus we have been able to predict the approximate numerical value of any physical property by calculation from the percentage composition in terms of the oxides, using constant factors for the oxides.

The values so obtained are only approximate, and the divergence between calculated and experimentally-determined values is often so great as to cast doubt upon the additive theory, or upon the factors accepted.

If we knew the actual compounds present in the glass, it should be possible by deriving factors for these, instead of for the oxides, to calculate the physical properties of their mutual solution with more certainty.

In this paper, an attempt has been made to choose probable forms of combination for soda, lime, and magnesia with silica, and to develop factors for density for these compounds. The compounds chosen are sodium di-silicate and calcium and magnesium meta-silicate. The remaining silica and the alumina are treated as oxides. Some evidence has been collected by Tillotson for the formation of $Na_2O \cdot 2SiO_2$. The meta-silicates of lime and magnesia are known as minerals.

Density Factors by Compounds

Six glasses were analyzed for silica, lime, magnesia, and alumina, and soda taken by difference. The composition of these glasses was then calculated in terms of the silicates of the bases above described and silica and alumina. Specific gravities were determined by weighing in air and in water fragments suspended by platinum wire, correcting for the weight of the wire in air and in water.

Calculations For calculation of the factors for density (specific gravity) the data on glasses 1, 3, and 5 in the table below were used, and simultaneous equations written, using 100 × the reciprocals of the

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Glass Division.) Received October 17, 1929.

densities found, or 100 × specific volumes, for the known members. Glass No. 1, for example, gave the following equation:

$$53.1N + 9.2C + 7.0M + 30.2S \quad 0.3A = 40.63,$$

where N represents the reciprocal-of-density or specific-volume factor for $Na_2O{\cdot}2SiO_2$, C for $CaO{\cdot}SiO_2$, M for $MgO{\cdot}SiO_2$, S for SiO_2 and A for Al_2O_3. From the literature, 2.24, the factor for SiO_2 proposed by Baillie, was accepted, since it represents a mean of those used by other investigators. Also, 2.75 was accepted for Al_2O_3, for similar reasons. The use of the reciprocals of these two as known quantities for S and A reduced the number of unknowns to three. Solving the three equations then gave: $N = 0.4028$, $C = 0.3342$, $M = 0.3684$. Expressed as densities, these figures correspond to:

$Na_2O{\cdot}2SiO_2$, 2.483; $CaO{\cdot}SiO_2$, 2.992; and $MgO{\cdot}SiO_2$, 2.714.

Application The values so obtained were then applied as factors and the densities of all six glasses calculated with the results shown in the table.

For comparison, the factors chosen by Winkelmann and Schott, Tillotson, English and Turner, and Baillie, respectively, were applied to the same

TABLE I

COMPOSITIONS AND DENSITIES

	Glasses						
	(1) Pressed ware	(2) Pickle bottle	(3) Milk bottle	(4) Pop-bottle	(5) Polished plate	(6) Blown tumbler	E. & T. Glass No. 10
Silica	74.1	76.1	74.1	72.2	73.8	75.3	74.59
Lime	4.4	5.1	5.0	8.8	11.7	4.5	10.38
Magnesia	2.8	3.2	3.4	0.4	0.3	3.1	0.30
Alumina	0.3	0.3	0.9	0.9	0.4	0.2	0.45
Soda	18.4	15.3	16.6	17.7	13.8	16.8	14.22
$Na_2O{\cdot}2SiO_2$	53.1	44.9	48.8	51.9	40.4	49.3	41.67
$CaO{\cdot}SiO_2$	9.2	10.5	10.3	18.2	24.2	9.3	21.46
$MgO{\cdot}SiO_2$	7.0	8.0	8.8	1.0	0.8	8.0	0.70
Al_2O_3	0.3	0.3	0.9	0.9	0.4	0.2	0.45
SiO_2	30.2	36.2	31.3	28.0	34.1	33.2	35.58
Density found (sp. gr.)	2.461	2.446	2.461	2.501	2.498	2.456	2.484
Density calculated by new factors	2.461	2.450	2.461	2.489	2.500	2.452	2.484
Density calculated by W. & S. factors (*a*)	2.419	2.415	2.436	2.428	2.427	2.415	2.430
Density calculated by T. factors (*b*)	2.463	2.470	2.467	2.483	2.497	2.458	2.483
Density calculated by E. & T. factors (*c*)	2.451	2.433	2.445	2.487	2.500	2.445	2.480
Density calculated by B. factors (*d*)	2.450	2.447	2.451	2.484	2.487	2.443	2.469

(*a*) Winkelmann and Schott, "Jena Glass."
(*b*) Tillotson, *Jour. Ind. Eng. Chem.*, p. 246 (1912).
(*c*) English and Turner, *Jour. Soc. Glass Tech.*, p. 156 (1921).
(*d*) Baillie, *Jour. Soc. Chem. Ind.*, p. 230 (1922).

glasses. The agreement, in the case of the Tillotson factors, was exceedingly good except for Nos. 2 and 4. Number 4, it should be remarked, is a green glass, and contains more than a trace of iron, unfortunately not separated from the alumina on analysis. This fact would account for a slightly higher density since iron oxide is more dense than alumina (5.3:4). The factors given by the German and English technologists, on the other hand, gave results at variance with experimental values. The reason may be that they were derived from glasses of distinctly different types from our soda-lime glasses.

Conclusion

While the data here presented are too fragmentary to be considered as demonstrating the validity of this method of predicting densities for all soda-lime glasses, it is hoped that application of the method to a larger number of glasses may show its usefulness.

In the table another glass is included whose composition and density were determined by other observers.[2] It will be noted that this glass differs in type from all except the polished plate specimen. Nevertheless the new factors lead to a calculated density agreeing with the measured value.

Using data on compositions and densities obtained in thesis work by Messrs. Gill and Rueckel at Ohio State University, 1929, the following values are presented, which tend further to show the validity of the new method:

TABLE II

	2-A	5-A	9-A	13-B	19-A
Silica	81.13	71.80	77.96	73.92	74.61
Lime	6.40	5.68	7.03	4.91	5.91
Magnesia	4.57	4.06	5.02	3.52	4.23
Alumina	2.10	3.47	1.54	2.35	1.72
Soda	5.80	14.99	8.45	15.30	13.53
$Na_2O{\cdot}2SiO_2$	17.11	44.04	24.75	44.95	39.67
$CaO{\cdot}SiO_2$	13.22	11.72	14.61	10.21	12.29
$MgO{\cdot}SiO_2$	11.40	10.10	12.60	8.80	10.60
Al_2O_3	2.10	3.47	1.54	2.35	1.72
SiO_2	56.16	30.66	46.50	33.72	35.70
Density found (sp. gr.)	2.429	2.501	2.447	2.461	2.466
Density calculated by new factors	2.418	2.480	2.450	2.460	2.466
Density calculated by W. & S. factors	2.432	2.462	2.440	2.439	2.441
Density calculated by T. factors	2.451	2.486	2.473	2.467	2.476
Density calculated by E. & T. factors	2.387	2.468	2.420	2.446	2.466
Density calculated by B. factors	2.397	2.465	2.429	2.448	2.449

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[2] English and Turner, *Jour. Soc. Glass Tech.*, p. 278 (1921).

THE DETERMINATION OF STRAIN IN GLASS BY A RADIATION METHOD[1]

By L. R. Ingersoll

ABSTRACT

The method of determining the strain in glass by a radiation measuring instrument is given and its adaptability if developed on a commercial basis.

Introduction[2]

Anyone taking up the study of the human eye for the first time would find himself puzzled by the two diametrically opposed statements which are frequently made about it. The one most often quoted is to the effect that the eye is the most wonderful and perfect of all optical instruments. The other, less frequently heard, is that the eye is not much of an optical instrument after all and that a much better one could be designed.

Now, as in most other cases, the truth undoubtedly lies between these two extremes. The eye is a wonderful piece of mechanism. When aided by the optical instruments which man has developed in the last half century or so, it becomes a tool for investigation which has no parallel. It has, however, certain well-defined limitations, and in some cases a man-made instrument may prove its superior.

One of these limitations is the matter of the wave-length to which the eye is sensitive. This is a spectral region limited to a single octave in frequency, ranging from the deep blue-violet to the darkest red. When the radiation to be studied is of shorter wave-length than this, *i.e.*, in the ultra-violet, the photographic plate is generally utilized; while if it is in the infra-red, the thermopile or similar instrument is called into play. The wave-length of the radiation worked with is generally determined by the conditions of the problem and is frequently settled by the transmission characteristics of the glass under investigation, if it be a problem dealing with glass.

The particular problem to be discussed in this connection is the matter of a substitute for the eye in the measurement of strain in glass. There are certain sorts of glasses which are nearly opaque, or at most translucent for ordinary light, but which will still transmit enough of the short infra-red radiation for purposes of measurement. Accordingly if a thermopile can be substituted for the eye it may be possible to measure strain and thereby check the quality of the annealing in glasses which could not be worked with at all by the ordinary visual method.

Optical Method of Strain Measurement

Before taking up the use of a radiation-measuring instrument in this

[1] Received July 26, 1929.

[2] See also *Jour. Opt. Soc. Amer. & Rev. Sci. Inst.*, **15**, 285 (1927).

connection we shall first look briefly at the theory of the optical method of strain measurement.

Let X and Y (Fig. 1*a* and 1*b*) be the "axes of strain" in a rather thin

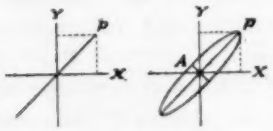


FIG. 1.

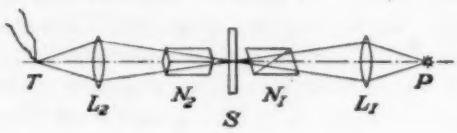


FIG. 2.

strained glass plate. Polarized light whose plane of vibration is P is allowed to fall nearly perpendicularly on this glass. It becomes resolved into two vibrations parallel to X and Y, respectively, and, because of the strain, a phase difference is introduced, so that after passing through the plate the vibration is elliptical in character. If this light is then examined with an analyzing nicol whose plane of transmission is A at right angles to P, light, proportional in intensity to the square of the heavy line will be transmitted. Accordingly the field will "light up," and the more the light the greater the strain.

Thermopile If, instead of the human eye, a thermopile is employed to measure the light transmitted through the second nicol the advantage is attained, as already mentioned, of being able to work with much longer wave-lengths.

There is also another advantage in the use of this method, and of considerable importance too, although it does not appear at first sight. After passing through the lens system used here in connection with the thermopile, the radiation strikes the glass under test in a conical beam, coming to a focus at the glass and diverging again to the second lens. This means that irregularities or roughnesses in the glass will merely redistribute the light in the cone and will not materially affect the results. This makes it possible to test very rough-surfaced diffusing glasses which could hardly be worked with in any other way.

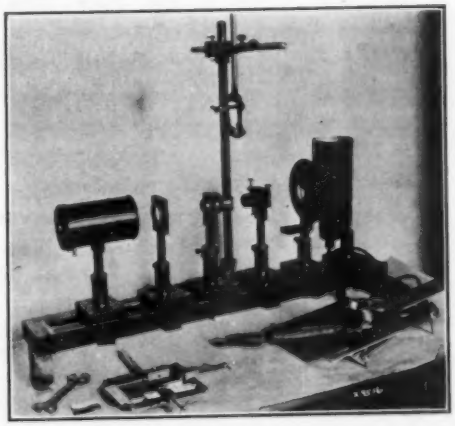


FIG. 2*a*.

The general arrangement of the apparatus is shown in Fig. 2. P is a brilliant "pointolite" lamp, L_1 and L_2, a pair of specially designed spherically

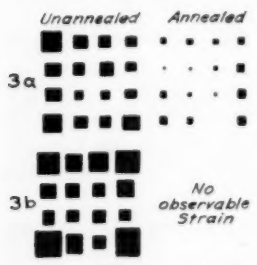
corrected lenses (made by the Bausch and Lomb Optical Company), which focus the radiation on the specimen S and afterward on the thermopile, T. N_1 is the "polarizing" and N_2 the "analyzing" nicol. Fig. 2*a* shows how all the parts are mounted on a heavy base, with special arrangements for holding the specimens. A sensitive d'Arsonval galvanometer used with the thermopile completes the equipment.

The operation of the apparatus is very simple. It is first very carefully adjusted so that the two nicols are exactly crossed, *i.e.*, transmit a minimum of light with no specimen between them. Partly because of the use of a conical beam, *i.e.*, nonparallel beam of light, it is impossible to reduce this minimum below about 0.1% of the incident energy, but this makes no practical difference in the final results. The specimen of glass is then inserted in position between the nicols, and the galvanometer deflection noted, using a shutter to get the zero.

As it is obvious that the deflection will depend upon the relative orientation of the direction of strain and the principal planes of the nicols, the specimen is mounted in a special holder, such as shown in Fig. 2*a* lying on the table, so that it can be rotated about the axis of the beam. The galvanometer deflections will then pass through maxima and minima 45° apart. From the maximum deflection, with certain small corrections, the depolarizing action of the specimen and consequently its strain may be calculated.

Graphic Representation of Results

A convenient standard size for the specimens tested was 5 by 5 cm. and a great many different ones were tried out in this connection. Various ways of showing the results graphically were tried and the manner finally decided upon is indicated in Fig. 3. Here the phase difference per centimeter thickness of the glass (and this is taken as a measure of the strain) is plotted as an area of a blackened square centering on the spot of the glass under test. This shows at once graphically the magnitude and location of the strains, and also the striking difference between the annealed and unannealed specimens.



FIGS. 3*a* and 3*b*.—Results on specimens. 3*a*, specimen 642 B.G. opal glass. 3*b*, specimen 706 K.Y. diffusing glass.

In addition to the tests on these small pieces, a considerable number of measurements have been made on rough-surfaced diffusing shades. Because of their great scattering action and the character of the surface these are more difficult to handle. It proved, however, quite possible to specify the approximate strains in various parts of annealed and unannealed specimens. It may be of interest to note that the strains in the unannealed specimens ran from three to fifteen times those in the annealed ones.

Adaptation for Factory Control

It is a fair question to ask if an apparatus of this sort could be developed on a commercial basis for the automatic testing of specimens on a large scale. Probably this could be done if the need justified the effort which would have to be put into it. The galvanometer used in the present case was a more sensitive one than would probably be usable in a factory, with its unavoidable vibration. For most of the work, however, much more energy was available than was actually needed for such a sensitive instrument and a much coarser one would have sufficed. With the exception of the galvanometer, the other parts of the apparatus are fairly rugged and would stand any reasonable amount of hard usage.

Acknowledgments In conclusion, my colleagues in this work, Professor C. E. Mendenhall and Mr. N. H. Johnson, and I want to acknowledge our indebtedness to the Corning Glass Works for supporting the fellowship under which this work was done, and particularly to Dr. J. T. Littleton, Jr., who suggested the problem and has furthered the work in every way.

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CORRECTION ON "RELATIONSHIP BETWEEN CHEMICAL COMPOSITION AND THE THERMAL EXPANSION OF GLASSES"[1]

By S. English and W. E. S. Turner

In a paper entitled "The Relationship between Chemical Composition and the Thermal Expansion of Glasses,"[2] we summarized the results by calculating a series of factors for each 1% of each of the constituent oxides employed, and quoted them as factors parallel with those of the factors worked out by Winkelmann and Schott some thirty-five years ago.

Quite recently, when preparing the results of another comprehensive research over a much wider range of temperature for presentation to a joint meeting of the Physical Society and the Society of Glass Technology, we were distressed to find that three considerable errors had crept into our table of values, *viz.*, in those of zinc oxide, baryta, and alumina.

These errors do not occur in the experimental data, nor in the linear expansion factor which we worked out from the experimental values, and, indeed, the errors have remained undiscovered by us simply because in all our tests applying our own factors we used the linear expansion factor and not the cubical expansion factor. In order, however, that our own factors and Schott's factors might bear a direct comparison we decided, when publishing, to quote cubical expansion values. This process of multiplying by three seems to have been entirely beyond us, and the results of the operation were disastrous. The linear expansion factor for zinc oxide was 0.70×10^{-7}. When multiplied by three we quoted it as 0.21, while the linear factors for alumina and baryta, *viz.*, 0.14 and 1.4, respectively, became 0.52 and 5.2.

The true values should obviously be

Zinc oxide	2.1
Alumina	0.42
Baryta	4.2

We very greatly regret these errors and all the consequences of misleading other investigators. This correction will be published at an early date, together with the results of the more extensive work, but in order to prevent further delay in making the very necessary correction this note has been drafted.

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[1] Received June, 1929.

[2] *Jour. Amer. Ceram. Soc.*, **10** [8], 551–60 (1927).

GREATER EFFICIENCY IN TUNNEL DRIERS[1]

By W. D. Richardson

ABSTRACT

The chief causes of inefficiency in waste-heat tunnel driers are (1) the cold bottom in the upper half of tunnels and (2) the hot air which enters the tunnels immediately goes to the top and does not return to the bottom but passes over the top of the ware and emerges at the receiving end of drier only partially saturated. A method is shown of insuring a hot bottom throughout the tunnel and of recirculating the air in the tunnel by means of small fans coöperating with steel baffles on the end of every third car, these baffles registering with beams across the top of the tunnel and with pilasters on the sides, thus dividing the tunnel into compartments, with alternately up and down circulation through the ware.

Introduction

Notwithstanding the improvements that have recently been made in the drying of heavy clay products, the engineer who has had experience in their manufacture realizes that there is much yet to be accomplished in greater efficiency and economy of this important operation. He also knows that the best drier that can be designed must be modified, in some cases quite radically, to adapt it to varying local conditions, such as the drying properties of the clay, the kind of product, the source of heat, etc.

Therefore, this brief study of the drier problem will concern only improvements that are of quite general application and will not go into details of construction, though often such minor details have an important bearing on economy of operation. In the application of the principle of the system described in this paper, moreover, only one form of tunnel drier is discussed, which may or may not be the most practical form in any special case.

A Hot Bottom a Requisite

Source of Heat Some years ago the patentee of a round, downdraft kiln announced that he would give a prize for the best slogan embodying the most essential requisite of a good downdraft kiln. Mr. Plumb, of Streator, won the prize with his brief answer, "A Hot Bottom." This same requisite is also applicable to a good tunnel drier and makes the radiating-flue, direct-fired drier efficient and economical under many conditions. Such a type of drier is most practical when the heat is supplied from the combustion gases of firing kilns that are not connected for regeneration, the gases being drawn through the radiating flues or pipes under the tracks by the induced-draft fan of the kilns.

Circulation from Top to Bottom It is easy enough to produce a circulation of heated air in the top of the tunnel. The problem is to get a fairly uniform circulation of air from bottom to top and from top to bottom throughout the whole length of the tunnel.

[1] Received September 11, 1929.

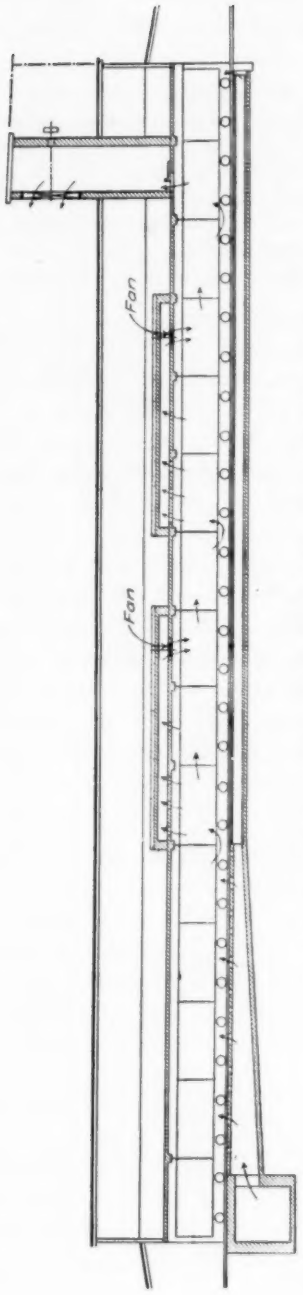


FIG. 1a.—Richardson recirculating tunnel drier: longitudinal section.

The improvements described are applicable to the radiating-flue drier as well as to what is known as the waste-heat drier, in which the hot air is drawn from the cooling kilns and blown into the drier.

It is common practice in waste-heat driers to blow the hot air into a supply duct running under and across the battery of tunnels at the discharge end of the drier, with branch distributing ducts extending under each track one-fourth to one-half of the length of the tunnel. These distribution ducts have graduated outlets in the top that discharge the hot air up through the cars of ware.

When this hot air has reached the top of the tunnel it never comes down, but passes longitudinally along the top of the tunnel to the outlet at the receiving end of the drier. This outlet may be at the top, but is often at the bottom for the purpose of drawing the warm air and moisture down to the bottom of the tunnels. Observation has shown that this practically affects only the last car or two at the receiving end of the tunnel. Thus it is often noticed that when the drier has stood over Sunday or a holiday the ware on the cars at the receiving end of the tunnel is drier than the ware on cars farther down the tunnel. One-half or more of the tunnel having a cold bottom, the ware on the bottom of the car is not dried much until the car comes under the hot-air inlets, when it is, in many cases, not prepared for such severe treatment and damage results.

Hot-Air Duct The hot-air distributing duct should be extended under the track the full length of the tunnel, covering this duct with cast-iron radiator plates and providing only a small outlet at the end of the duct to insure

enough circulation to keep the duct hot. In some cases a galvanized or Armco iron pipe is employed, instead of cast-iron plates for the extension of the distributing ducts. The pipe is cheaper and gives more radiating surface but the cast-iron plates resting on the rails have some advantages.

Recirculating of Air In the ordinary waste-heat tunnel drier, the hot air, after having been blown quickly up through the cars, passes along the top of the tunnel, drying the ware on the top of the car, often too rapidly, especially where the space over the ware is small, and emerges at the end of the tunnel with low humidity. This often causes checking of the ware on top of the car and, in any case, is not an economical use of the heat, the air emerging with only a small per cent of saturation.

To overcome this defect in the tunnel drier, provision has been made for recirculating the hot air in the top of the tunnel, which, together with a bottom kept hot by a radiator duct, makes for greater efficiency and economy.

Baffles to Prevent Hot Air to Pass Longitudinally To prevent the longitudinal passage of the hot air in the top of the tunnel, reinforced-concrete beams about eight inches wide are used projecting down from the top of tunnel four to six inches at the end of every car length, except in the hot-air entry zone. These drop beams, together with sheet-iron plates fastened on the forward frame of every second or third car, depending upon length of tunnel, form baffles dividing the tunnel into movable compartments. The sheet-iron baffles just clear the concrete beams of the tunnel and also walls or two-inch pilasters on the sides of tunnel, and extend down to the bottom deck, leaving the space under the car open for the passage of the hot air and vapor.

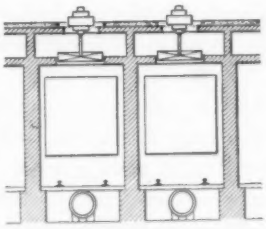
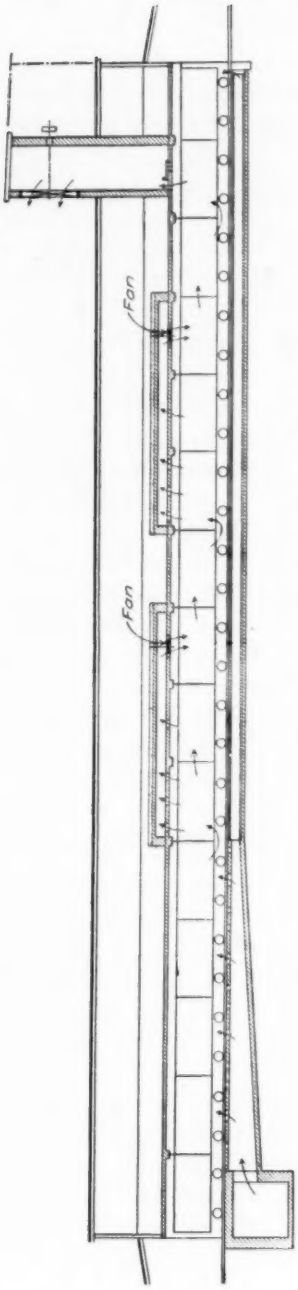


FIG. 1*b*.—Richardson recirculating tunnel drier: cross-section.

In this way the space over the top of ware may be ample, since there is no chance for a longitudinal movement over the cars, except during the brief interval of the movement of the cars down the tunnel, properly only one car at a time, no cars being taken out of tunnel until there is a car ready to be put in. It is well known that to secure the maximum output of the drier all the tunnels should be kept filled with loaded cars all the time.

Recirculation through the Cars To provide for recirculation of the hot air through the cars of ware, ducts are constructed over the top of tunnel, the full width of the tunnel, nearly three car lengths and twelve inches deep having inlets over the two cars in advance. A disk fan at the other end of the duct discharges on to the center of the third car back. Above the second car back of this fan are the



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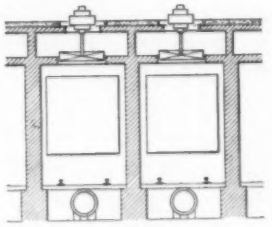

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inlets of another duct constructed and provided with a fan in the same manner.

The 24-inch propeller fan of Armco iron with its vertical motor has been especially designed for this system. The ball-bearing motor on the upper end of the shaft is outside of the duct and the disk fan on the lower end of the shaft is suspended in a circular opening in the concrete top of the tunnel. The shaft is especially large in diameter for the small motor and the bearings are all outside of the duct and easily accessible. The whole rig is self-contained, mounted on a special cast-iron base that can be bolted into place in a few minutes.

Air Discharge At or near the receiving end of the drier is the top outlet, with sliding board damper for regulating so as to discharge an equal volume of air per minute from each tunnel to stack or fan, thereby also adjusting the humidity of the emergent air to near the point of saturation and insuring the utmost economy of heat. The recirculation fan is provided with a one-half H.P. motor, 1140 r.p.m., though the actual power consumed is somewhat less.

Operating the drier by the movement of one car at a time down the tunnels, taking a car out of each tunnel and immediately putting a car into each tunnel at the receiving end, thus keeping all tunnels always filled with cars of ware. Every car, in turn, stands during the interval between movements directly under both recirculating fans.

The illustrations show this system so clearly that further description is not necessary.

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GLOST WARPING OF WHITE WALL TILE[1]

By T. Dwight Tefft

ABSTRACT

A method for measuring the warpage of wall tile is presented and a study is made of the warping results obtained from variations of glaze composition. Conclusions are drawn from tests with zinc oxide, calcium, barium, and magnesium.

Introduction

It is well known that plain wall tile always warp convexly (glaze side out) in the glost fire. Each step in white wall tile manufacture may contribute a cause for this. The body composition, the glaze composition, the fineness of grain of the body materials used, the design or shape of the back, the method of filling dies and pressing, the methods of placing both in the bisque and glost kilns, the glaze application to the body, and the firing temperature, all have more or less influence in the amount of warping obtained.

This investigation gives a simple method for measuring the warpage, and makes a study of the warping results obtained from variations of the glaze composition only.

Body and Glaze

A commercially manufactured white wall tile body and glaze were used as the basis for this investigation. The tile were exceptionally white and uniform in shade, with no shivering or crazing.

The rational analysis of Body A is feldspar 10, clay substance 40, and flint 50. The firing temperature is 2390°F or cone 9.

The glaze is of the fritted boric acid type, from the following formula:

Glaze I	K_2O	0.088	Al_2O_3 0.250	SiO_2	2.76
	Na_2O	0.174				
	CaO	0.236		B_2O_3	0.523
	MgO	0.006			
	PbO	0.496			

Oxygen ratio 1:1.66
Firing temperature = 2066°F or cone 01.

This body and glaze was carefully studied from all angles, until the average amount of warping produced by the glaze under standard manufacturing conditions was reasonably well determined.

Method of Measuring Warpage

A micrometer was inserted in the center of a carefully machined steel bar. Near the ends of the bar ($5^1/_2$-inch centers) two narrow chisel point

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (White Wares Division.) Received Jan. 14, 1929.

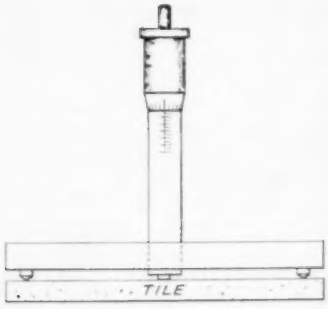

FIG. 1.

lugs were attached, giving three contact points on a perfect level plane when the micrometer was set on a zero reading. Figure 1 shows this apparatus.

Tile were always measured on the face before and after glazing, the micrometer screw being turned to such a position that no light passed beneath the three points coming in contact with the tile. When recording readings, a minus sign was used to indicate concave warping and a plus sign to indicate convex warping. Table I shows the method used for tabulating the amount of glost warping obtained.

TABLE I

Tile No.	Bisque	Glost	Warpage (0.000 inches)
1	−8	−1	7
2	−4	+4	8
3	+2	+6	4
4	−6	+2	8
5	+1	+8	7
6	0	+7	7
7	−7	+3	10
8	−5	+3	8
9	−4	+2	6
10	−6	0	6
11	−5	+1	6
↓	↓	↓	↓
99	−7	+1	8
100	−6	+2	8

Warping Obtained with Glaze I and Variations of Its RO Group

Six- by three-inch wall tile were taken at random from the bisque stock, numbered, measured, and recorded in the bisque column. They were then glazed on a coating machine, the glaze always being applied at a standardized wet weight of three pounds seven ounces to the quart. After firing in the commercial kilns, each tile was again measured and recorded in the glost column opposite its corresponding number. After measuring several hundred tile in this way a mean warp of 0.0075 inch was arbitrarily chosen, assuming that all tile falling below this were flat (not warped), while those showing 0.008 or more were considered as warped. This plan permits the tables to be condensed and gives the relative amounts of glost warping produced in percentage terms. By this plan the glost warping, resulting from Glaze I was found to be 41%. The greatest warping ever found in any one tile was 0.012 inch, while the lowest was zero.

With this standard as a working basis, four glazes, II to V inclusive, varying the RO contents of each glaze, were prepared. These RO variations

introduced or increased unfritted zinc, calcium, barium, or magnesium oxides, respectively, at the expense of the lead content. The R_2O_3 and RO_2 contents in all glazes remained constant, as given for Glaze I formula. Table II gives the RO group formulas for Glazes I to V, inclusive.

TABLE II

Glaze No.	I	II	III	IV	V
K_2O	0.088	0.088	0.088	0.088	0.088
Na_2O	0.174	0.174	0.174	0.174	0.174
CaO	0.236	0.236	0.336	0.236	0.236
MgO	0.006	0.006	0.006	0.006	0.106
ZnO		0.100			
BaO				0.100	
PbO	0.496	0.396	0.396	0.396	0.396
Total	1.000	1.000	1.000	1.000	1.000

These glazes were carefully prepared and applied by the glaze coating machine at the standard weight, 100 tile being marked, measured, and recorded for each glaze. They were fired in the commercial glost kilns, every possible precaution being taken to duplicate standard manufacturing conditions throughout the test. After obtaining the results from these glazes, and drawing conclusions, four additional glazes IA, IB, IIA, and VA, were made up and run through the usual procedure to verify the conclusions deducted from the first group of glazes (I to V).

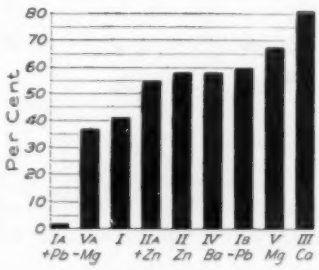

FIG. 2.

Glazes IA and IB were variations of the lead content only. In other words they were simply variations in the degree of fusibility for Glaze I.

Table III gives the formulas of these two glazes.

TABLE III

	IA	IB				
K_2O	0.088	0.088				
Na_2O	0.174	0.174				
CaO	0.236	0.236	Al_2O_3	0.250	SiO_2	2.76
MgO	0.006	0.006			B_2O_3	0.523
PbO	0.596	0.396				
Total	1.100	0.900				

These formulas have not been reduced to unity, as the variation is more readily noted as shown in the table. Their oxygen ratio becomes 1:1.63 and 1:1.72, respectively.

Glaze IIA was a simple addition of zinc oxide, leaving the lead content

remain constant, instead of replacing the lead with zinc as in Glaze II. The formula (not reduced to unity) was as follows:

Glaze IIA

K_2O	0.088				SiO_2	2.76
Na_2O	0.174					
CaO	0.236	Al_2O_3	0.250	{		
MgO	0.006				B_2O_3	0.523
ZnO	0.100					
PbO	0.496					

Glaze VA eliminated the magnesium oxide entirely, the formula being:

Glaze VA

K_2O	0.09				SiO_2	2.76
Na_2O	0.18					
CaO	0.24	Al_2O_3	0.25	{		
PbO	0.49				B_2O_3	0.52
	1.00					

Oxygen ratio 1:1.67

Results

A brief description is given of each glaze in comparison with Glaze I.

(I) Standard Glaze Glaze I gave an exceptionally white, uniform shade, with no shivering or crazing. The surface texture was very mature with comparatively little suggestion of the "eggshell" or "kidglove" texture commonly seen on the market. The flowing or banking of the glaze at the edges of the tile was negligible.

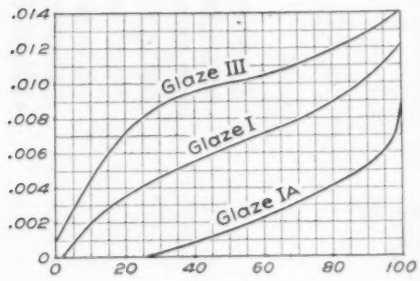

FIG. 3.

(IA) Lead Addition A very fusible glaze with smooth mature surface texture, quite badly banked at edges, and slightly off shade.

(IB) Lead Decrease Immature or underfired glaze, with a wavelike surface. The shade was fully developed, but there was no banking at the edges.

(II) Zinc Replacement There was no difference detected in the shade, or amount of banking at the edges from Glaze I, but there was a very marked development of the "eggshell" surface texture.

(IIA) Zinc Addition Similar to Glaze II.

(III) Calcium Replacement The development of shade was same as Glaze I. There was no visible banking at the edges, yet the surface texture was fully matured, with no "eggshell" texture like the zinc glazes.

(IV) Barium Replacement This glaze gave the same shade as Glaze I, with slightly less banking, but in the banked edges there were cloudlike patches in suspension. Undoubtedly the barium was not completely taken into solution.

(V) Magnesium Replacement This glaze was a full shade whiter than the other glazes. There was no banking at the edges, and some development of the "eggshell" texture, but not as marked as in the zinc glazes.

(VA) Magnesium Eliminated This glaze was identical with Glaze I.

In Table IV we have a condensed summary of the warping produced by each glaze expressed in percentage terms. Also the greatest warping and the lowest warping of any one tile, and the average of one hundred tile shown in thousandths of an inch.

TABLE IV

Glaze No.	IA	I	IB	II	IIA	III	IV	V	VA
Per cent warped	1	41	60	59	55	81	59	68	37
Per cent flat	99	59	40	41	45	19	41	32	63
High warp	9	12	13	14	13	14	13	14	12
Low warp	0	0	3	0	2	1	1	1	0
Average	2.43	7.32	7.99	8.02	8.02	9.84	7.98	8.68	6.54

The percentage of warped tile plotted in Fig. 2, the height of each column along the abscissa representing the number of tile warped, gives a comparable picture of the results.

The actual amount of warping produced by Glazes I, IA, and III is also given in detail by the curves as plotted in Fig. 3. These three are chosen for plotting as they show the standard glaze in comparison with the two extremes of greatest and lowest warping produced.

Conclusions

Seger[2] gives an "order of fusibility" for "those metallic oxides which yield colorless glasses or glazes," and in this work the general trend has been as follows: that each oxide introduced into the glaze has produced more or less warping according to whether it rendered the glaze more or less fusible. Hence the general conclusions are deducted.

(1) Any oxides or elements of change in a glaze, which tends to make it more refractory will produce more glost warping on a given body. And conversely, any change increasing the fusibility of a glaze will produce less glost warping. Glazes IA and IB, simple variations in the degree of fusibility of Glaze I, verify this conclusion.

[2] Collected Writings of Herman A. Seger, Vol. II, p. 568.

(2) Zinc oxide does not make a glaze whiter, is responsible for the "eggshell" texture common to wall tile glazes, and increases the amount of glost warping. Glaze IIA (zinc addition) produces nearly the same amount of warping as Glaze II showing the zinc influence to be strong even when the lead content remains unchanged.

(3) Excessive use of calcium develops excessive warping. An increase of less than 30% to the original lime content increases the warping 100%. There is a danger point beyond which calcium must not be used in glazes of this type.

(4) Barium is not easily soluble and increases warping approximately the same as zinc oxide.

(5) Magnesium tends to develop whiter shades in colorless glazes, but also greatly increases the amount of warping. Note a decrease of 4% warping by the elimination of 0.006 MgO from the original Glaze I.

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SOUTH MILWAUKEE, WISCONSIN

CHEMICAL CHANGES IN CLAY AND CLAY-LIME MIXTURES ON FIRING[1]

By C. J. Frankforter and J. N. Detrick

ABSTRACT

The results of the experiments indicate that lime added to a clay, of the type studied here, combined chemically with certain of the various constituents of the clay when the mixture was fired at 1000°C. There is also an indication of reactions between iron oxide and silica. The exact nature and extent of these several possible reactions cannot be determined from the data of this limited experimental work.

It would be of great value for work of this kind if more information was available relative to the chemical action of various reagents upon the several constituents of clay. Obviously it would be necessary to use pure substances representing these constituents rather than any mixture of them.

Work was undertaken to obtain indication of the chemical changes which occur on firing a low lime clay and the same clay with calcium-carbonate additions.

Introduction

Nebraska has an abundance of clay, the most important being found in the Carboniferous and Dakota Cretaceous formations.[2] The geological proximity of beds of Nebraska limestone to some of the clay and shale deposits and the possibility of improving certain physical properties of various finished products by combining the two raw materials has been referred to by Rymes.[3]

The clay sample studied was taken from the pits of the Yankee Hill Brick Company of Lincoln, Neb., and is the lower shale or basal deposit of the Dakota formation.

Historical In 1927, Rymes[3] studied the effects of an addition of lime to a Nebraska clay on the physical properties of fired products.

The phase relations of a number of one-, two-, and three-component systems of substances thought to be present in clays have been studied by Bowen,[4] Rankin,[5] and others.

Asch and Asch[6] in their H.P. theory, assume all "purified clays" to be definite chemical compounds and attempt to explain the important ob-

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[1] An abstract of a thesis presented to the faculty of the Graduate College of the Univ. of Nebraska in partial fulfilment of the requirements for the degree of Master of Science, Department of Chemistry. Received August 8, 1929.

[2] Barbour, Nebr. Geol. Surv., Pt. 1, p. 202 (1903).

[3] *Jour. Amer. Ceram. Soc.*, **11** [1], 46–60 (1928).

[4] N. L. Bowen, *Amer. Jour. Sci.*, **35,** 577 and 583 (1913); N. L. Bowen, *ibid.*, **40,** 171, 174, 175, 178, 197 (1915); N. L. Bowen and J. W. Greig, *Jour. Amer. Ceram. Soc.*, **7** [4], 238, 254 (1924).

[5] Rankin and Wright, *Amer. Jour. Sci.*, **39,** 5, 11, 40 (1915); Rankin and Merwin, *ibid.*, **45,** 301 (1918); Rankin and Merwin, *Jour. Amer. Chem. Soc.*, **38,** 571 (1916).

[6] Asch and Asch, The Silicates in Chemistry and Commerce.

served phenomena of clays by means of this theory. Clark,[7] Vernadsky,[8] and others have also suggested formulas for the kaolinite molecules, but as pointed out by Mellor and Holdcroft,[9] it is difficult to accept any of them entirely.

Considerable effort has been made to determine the effect of firing on clays[10] and also the effect of various constituents[11] on the properties of clays.[12]

Thermal expansion data[13] seem to indicate some of the physical and chemical reactions which take place in a clay on firing.

McVay and Thompson[14] and Westman[15] have made X-ray studies and have given a bibliography of previous investigations.

Experimental

The Clay The ultimate analysis of the clay used in this study is given in Table I. Table IA is the same data recalculated to a basis of a material free of organic and volatile matter. Moisture was determined by drying in a Freas oven for twelve hours at 100 to 110°C. Organic and volatile matter was determined by heating to constant weight in an electric muffle furnace at approximately 1000°C. The data presented are an average of a large number of determinations, as are the other analyses reported in this paper.

	Table I	Table IA
Silica	71.31	76.05
Alumina	17.12	18.28
Ferric oxide	5.24	5.59
Lime	0.67	0.72
Alkalis	trace	
Manganese	trace	
Magnesia	trace	
Chlorides	none	
Sulphates	trace	
Moisture	1.54	
Organic and volatile	4.70	

Rational-Ultimate Analysis A two-gram sample was digested for twenty hours with 50 cc. of 30% sulphuric acid. The acid was then diluted slightly, filtered off, and the residue washed thoroughly with hot water. The filtrate was set aside for analysis

[7] F. W. Clark, "The Constitution of the Silicates," Washington, XXXII.
[8] Vernadsky, *Zeit. Kryst.*, **34**, 37 (1901).
[9] Clay and Pottery Industries, Vol. I, edited by J. W. Mellor.
[10] *Trans. Ceram. Soc.* [Eng.], **23**, 322 (list of references) (1923–24).
[11] H. Ries, Clays: Occurrence, Properties and Uses.
[12] A. E. MacGee, *Jour. Amer. Ceram. Soc.*, **10**, 561, 568 (1927).
[13] A. E. R. Westman, Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 181.
[14] T. N. McVay and C. L. Thompson, *Jour. Amer. Ceram. Soc.*, **11**, 829, 841 (1928).
[15] A. E. R. Westman, Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 193.

and the residue was digested on the steam bath for 15 hours with 30 cc. of a 10% solution of sodium hydroxide. This mixture was diluted, filtered through the same filter paper used for the acid mixture and well washed with hot water. This filtrate was set aside for analysis and the residue again digested with the filter paper for 15 hours with 50 cc. of a 20% solution of hydrochloric acid. It was found impossible to wash all the material completely from the paper. The hydrochloric acid solution was filtered and set aside. The residue from the hydrochloric acid treatment was fused with sodium carbonate and the fusion taken up in hydrochloric acid in the usual manner. The four solutions were then analyzed.

Hereinafter the sulphuric acid solution is referred to as fraction No. 1, the sodium hydroxide as fraction No. 2, the hydrochloric acid solution as fraction No. 3, and solution of the fusion as fraction No. 4.

Silica, alumina, iron oxide, and calcium oxide were determined, these being the only constituents present in appreciable proportions.

All fusions were made in platinum and all digestions in porcelain.

The rational-ultimate analysis of the clay before firing gave the following results:

TABLE II*

	Fraction No. 1	Fraction No. 2	Fraction No. 3	Fraction No. 4
Silica	0.25	15.02	0.69	60.10
Alumina	3.96	3.61	3.39	7.37
Ferric oxide	4.70	0.09	0.69	trace
Calcium oxide	0.18	0.16	0.07	0.31

* In all but Table I, the data presented are calculated on the basis of a material free from moisture and organic and volatile matter.

Firing of Samples Briquets were formed of the clay and of clay plus six parts of calcium oxide in the form of calcium carbonate. All briquets were fired at the same time in a small electric muffle furnace. Five hours were required to bring this furnace and contents to a maximum of 1007°C. This temperature was held for four hours. The furnace and contents were allowed to cool to room temperature in ten hours.

The briquets did not warp. They appeared to be fired uniformly throughout their mass. They were of a reddish buff color, slightly more red than the raw clay. Lime additions made no appreciable difference in the colors.

Analysis of Fired Samples The briquets were ground in a sample grinder to approximately the same degree of fineness as was the original unfired clay.

TABLE III

	Fraction No. 1	Fraction No. 2	Fraction No. 3	Fraction No. 4
Silica	0.10	17.91	2.21	56.00
Alumina	1.13	0.77	4.92	11.82
Ferric oxide	1.76	0.04	0.96	2.92
Calcium oxide	0.14	0.14	0.28	0.14

TABLE IV

	Fraction No. 1	Fraction No. 2	Fraction No. 3	Fraction No. 4
Silica	0.65	15.10	6.67	48.82
Alumina	10.33	0.63	1.98	5.49
Ferric oxide	2.10	0.01	0.37	2.94
Calcium oxide	2.54	0.06	3.84	0.42

Rational-ultimate analyses of the fired clay and the fired lime-treated clay were made, yielding the results in Tables III and IV, respectively.

Discussion

(1) Highly accurate results with the rational-ultimate analysis were not obtained, even when the utmost care was taken to eliminate all possible sources of error, due to the difficulty of obtaining absolutely uniform samples, and to the fact that such a large number of determinations were made from a single, comparatively small original sample.

(2) It was necessary to devise a reliable basis upon which the data for the raw clay, the fired, untreated clay, and the fired, lime-treated clay could be properly compared.

It was finally decided to convert the data as shown in Table V. These figures represent the per cent of the total amount of any one constituent found in the clay, which was obtained in any particular fraction. For example, the figures, 0.32, the first in the column headed "raw," mean that 0.32% by weight of the total percentage of silica found in all four fractions, was obtained in Fraction No. 1. Thus all the data are placed upon a comparable basis. This method possessed an additional advantage over others considered in that, for comparative purposes, the distortion of apparent results due to any constant error was eliminated.

TABLE V

	Raw clay	Untreated clay (fired)	Lime-treated clay	Lime-treated clay (fired)
Fraction No. 1				
Silica	0.32	0.14	0.32	0.92
Alumina	21.60	6.08	21.60	56.08
Ferric oxide	85.62	30.98	85.62	38.80
Calcium oxide	24.70	19.92	92.96	37.00
Fraction No. 2				
Silica	19.79	23.48	19.79	21.18
Alumina	19.69	4.12	19.69	3.42
Ferric oxide	1.75	0.65	1.75	0.23
Calcium oxide	21.90	19.92	2.05	0.93
Fraction No. 3				
Silica	0.92	2.90	0.92	9.36
Alumina	18.49	26.40	18.49	10.75
Ferric oxide	12.62	16.88	12.62	6.77
Calcium oxide	10.20	39.85	0.95	55.90
Fraction No. 4				
Silica	78.97	73.48	78.97	68.53
Alumina	40.20	63.40	40.20	29.74
Ferric oxide	trace	51.48	trace	54.19
Calcium oxide	43.20	20.28	4.03	6.04

(3) The data noted in column three of Table V were obtained from a "calculated" rational-ultimate analysis of the lime-treated clay before firing. The calculations were made on the assumption that all of the calcium added as calcium carbonate would be obtained in fraction No. 1 and that the other constituents originally present would be distributed among the four fractions in the same proportion as they were in the rational-ultimate analysis of the raw clay.

(4) Table VI gives the molecular ratio of the amounts of the various constituents found in the different fractions of the rational-ultimate analyses. These ratios were calculated from the data in Table V and the ultimate analysis of the raw and lime-treated clay. The data noted in columns one and two of Table VI are comparable both horizontally and vertically. The data in columns three and four are also comparable in the same manner.

TABLE VI

	Raw clay	Untreated clay (fired)	Calcium-treated clay	Calcium-treated clay (fired)
Fraction No. 1				
Silica	0.716	3.02	0.666	1.90
Alumina	6.79	1.91	6.31	16.4
Ferric oxide	5.26	1.90	4.90	2.22
Calcium oxide	0.553	0.447	20.35	8.10
Fraction No. 2				
Silica	44.00	52.20	41.00	43.80
Alumina	6.19	1.295	5.78	1.00
Ferric oxide	0.107	0.04	0.10	0.103
Calcium oxide	0.491	0.447	0.449	0.203
Fraction No. 3				
Silica	2.02	6.44	1.89	1.94
Alumina	5.81	8.30	5.40	3.14
Ferric oxide	0.775	1.037	0.72	0.387
Calcium oxide	0.228	0.893	0.308	12.25
Fraction No. 4				
Silica	175.5	163.3	163.2	141.9
Alumina	12.63	19.90	11.75	8.7
Ferric oxide	trace	3.16	trace	3.1
Calcium oxide	0.968	0.455	0.882	1.32

(5) The clay evidently contained a large amount of free silica. The ratio of the total silica to the total alumina was approximately 7 to 1. Nearly 79% of this silica was found in the residue insoluble in sulphuric acid, sodium hydroxide, and hydrochloric acid.

Inspection of this residue showed it to be composed largely of sandy grains, some of which were transparent. Along with these were finely-divided particles of a material apparently crystalline in character. The mass was light gray in color.

The feldspars if present might be expected to appear in this residue but the fact that the alkalis were not found in any appreciable quantity, seemed to preclude the possibility of any but anorthite. Forty-three per cent of

the lime present was found in the residue and at least this much calcium oxide was probably present as anorthite.

The ratio of the silica and alumina found in the residue was about 14 to 1. The greater portion of this silica was no doubt silicon dioxide. Some of the silica was surely combined with lime and alumina as anorthite and some no doubt in the form of other insoluble alumino-silicate.

Forty per cent of the total alumina was found in fraction No. 1, which would indicate that other insoluble silicates besides anorthite were present, and, as other constituents than silica and alumina were not found, one is safe in stating that they were silicates of aluminum only.

The ratio of the total silica and alumina found in the other three fractions was 2.48 to 1. There was an excess of silica above that required for the alumina combined as kaolinite, which would indicate that some free silica and possibly some anorthite had been attacked by the treatment.

The iron oxide in the clay was probably present as hematite or limonite or both, but it is possible that some of it may have been combined in the form of a complex silicate. All the iron oxide, however, was obtained in the first three fractions, 85% of it in the first fraction.

Since the clay contained no more than traces of carbonate, sulphate, or chloride, the bulk of the calcium oxides obtained in the first three fractions must have been present originally as anorthite which was decomposed by the treatment.

(6) One of the most interesting changes produced by firing was the appearance of 51% of the iron oxide in the residue. Since ferric oxide is soluble in strong acids and can be dissolved even when it has been heated to quite high temperatures, the high percentage of iron oxide in the residue must indicate that about half of it had entered chemically into some combination which was not completely decomposed, if indeed it was attacked at all, by the treatment of the rational-ultimate analysis. If such a hypothetical compound was formed between iron oxide and silica and this compound was attacked, as it might be reasonable to assume, by sulphuric acid or hydrochloric acid or both, depending upon the time and temperature of treatment, then the iron oxide in the portion decomposed by the sulphuric acid would be obtained in fraction No. 1 and by far the greater portion of the corresponding silica in fraction No. 2. The iron oxide and silica in the portion decomposed by hydrochloric acid would be obtained in fraction No. 3.

It is well known that under certain conditions the decomposition of a silicate by an acid may yield a form of silica, which if not in true solution, nevertheless passes into the filtrate. Conditions of treatment may, of course, change the results so that silica is largely precipitated. Mellor[16]

[16] See footnote 9.

states that a cleaner separation of silica occurs when a silicate is decomposed by sulphuric acid rather than hydrochloric acid. The ratio of the ferric oxide obtained in fraction No. 1 to the silica obtained in fraction No. 2 which is in excess of that obtained in the same fractions by treating the unfired clay, is 1 to 4.3. Likewise the ratio of the iron oxide obtained in fraction No. 3 to the silica in fraction No. 3, which is in excess of that obtained in the same fractions for the unfired clay, is 1 to 4.26.

It is possible then that the iron oxide had united with a portion of the free silica to form a compound with a formula represented as (Fe_2O_3:$4SiO_2$). This idea is further evidenced by the fact that the increase in the amounts of silica found in fractions No. 2 and No. 3 came at the expense of that appearing in fraction No. 4, which in the unfired clay had existed in large proportion as free silica. This statement is made despite the fact that generally speaking only ferrous oxide unites at all readily with silica. It is realized that there will be a slight weight-ratio difference in calculating ferrous and ferric iron in chemical combinations. It is possible that both forms of iron exist in raw and fired clays while all analytical data reported consider the iron in the ferric form only.

There was an increase noted in the amount of alumina obtained in fractions No. 3 and No. 4 and a decrease in the amounts obtained in fractions No. 1 and No. 2 when comparing the raw and fired clays. These decreases in the alumina noted in fractions No. 1 and No. 2 were in approximately the same proportion, as were the increases in the amounts obtained in fractions No. 3 and No. 4. The fact that kaolinite decomposes into silica, alumina, and water on heating to about 550°C is generally accepted.

It is the opinion of numerous investigators,[17] that at about 1200°C the silica and alumina again unite to form sillimanite. Miehr[18] has also reported that a definite relation exists between the amounts of mullite formed and the alumina contained in the clay substance, but no appreciable amounts are formed until temperatures of about 1400°C are reached. Very probably then, neither sillimanite nor mullite were formed in appreciable quantities in the firing of the clay in these experiments, since the maximum temperature encountered was only 1007°C.

Any alumina set free by the decomposition of kaolinite would most probably have been present as free alumina which is very difficult to dissolve in acids or alkalis after being heated to a high temperature. This explanation would account for the increase in alumina in fraction No. 4. The fact that more was dissolved by the hydrochloric than by the sulphuric acid or sodium hydroxide is probably what might be expected.

(7) Tables V and VI show a number of instances where the apparent

[17] Mellor and Holdcroft, *Trans. Ceram. Soc.* [Eng.], **10**, 94, 120 (1910–11).
[18] Miehr, *Ber. deut. keram. Ges.*, **9**, 6 (1928).

changes produced by heating the clays with and without lime additions are similar. Over 50% of the iron oxide was obtained in fraction No. 4 of both. The amount of silica obtained in fraction No. 4 of the fired specimens was decreased appreciably as compared with the silica in fraction No. 4 of the unfired specimens.

In both cases firing increased the amount of silica obtained in fractions No. 2 and No. 3, decreased the amount of ferric oxide in fraction No. 1, and decreased the alumina found in fraction No. 2.

(8) The most notable changes produced by firing the untreated and the lime-treated clay was the difference in the manner in which the alumina content of the various fractions changed. Firing produced a decrease in the alumina content of fraction No. 2 for both the untreated and the lime-treated samples, but for the untreated there was an increase in the alumina of fractions No. 3 and No. 4 and a decrease in fraction No. 1. In the case of the lime-treated clay there was a decrease of alumina in fractions No. 3 and No. 4 and an increase in fraction No. 1. Quite evidently the reactions into which the alumina entered were of a different character for the high-calcium clay than for the low-calcium clay. This difference was no doubt caused by the addition of lime.

To account for the increase in the alumina content of fraction No. 1 it is necessary to assume that it came from some compound which was decomposed by the sulphuric acid. If it had existed as free alumina it is improbable that it would have been attacked to the extent noted, due to its well known, slight solubility after being heated.

In fraction No. 1 the ratio $CaO:Fe_2O_3:Al_2O_3:SiO_2$ is approximately 4:1:8:1. It is possible that a portion of the lime added may have combined with alumina to form a compound approximately of the constitution $CaO:2Al_2O_3$.

As might be expected the bulk of the lime added to the raw clay appeared after firing in fractions No. 1 and No. 3. It is possible that all of the lime added would not have combined but it seems likely that it would. Certainly, if it had not combined at least in part, none would have passed fraction No. 1. More than half of the lime added, however, appeared in fraction No. 3.

There was also a surprising increase noted in the amount of silica obtained in fraction No. 3. This would indicate that the silica found there had existed in some compound decomposed by the hydrochloric acid. Otherwise it would in all probability have been obtained in fraction No. 2 or No. 4. It is improbable that silica would be soluble in hydrochloric acid to the extent noted except under such conditions.

It is interesting to note the ratio of the amounts of calcium oxide and silica in fraction No. 3, which in excess of the amounts obtained in the same fraction of the unfired clay is approximately 2 to 3.

(9) Ries[19] has stated that the addition of lime to a clay tends to diminish or "bleach" the red color noted when the clay carries appreciable amounts of iron oxide. No explanation is given for this "bleaching" action. No "bleaching" of the iron-oxide color was noted in these experiments. It is possible, of course, that larger amounts of lime or higher firing temperature might have caused the red color to diminish.

If a clay was heated to complete fusion or liquefaction, the resulting mass would be homogeneous. If a single complex compound would not be formed there would surely be a phase equilibrium.

Chemical action begins at comparatively low temperatures. Compounds or pseudo-compounds produced, or beginning to be produced, at temperatures of 1000 to 1200°C are responsible for the mechanical and physical properties of finished brick. If these compounds or the "chemical trend" taken by the clay constituents could be determined it might be possible to control the manufacture of brick more accurately. It might be possible to correct "faults" in natural clays by the addition of other substances; to produce a mixture which when fired would possess such properties as might be desired.

It had been hoped that it would be possible to establish a relationship between the chemical constitution and physical properties of clay. Unfortunately time did not permit of sufficient work being accomplished. For a clay of any type it would be necessary to carry out analyses of various lime mixtures after firing at different temperatures. Analyses of the raw clay after firing at different temperatures would also be needed. The results to date can be merely "sign posts" pointing in the proper direction.

Acknowledgment The junior author wishes to express his most sincere thanks and appreciation to Prof. Frankforter who suggested the problem and without whose assistance, completion of the work would have been impossible.

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[19] See Footnote 11.

THE ACCURATE MEASUREMENT OF HIGH TEMPERATURES[1]

By W. E. Forsythe

ABSTRACT

The standard temperature scale is defined and methods of realizing it both in laboratory and in factory practice are outlined. Methods of measuring temperature from very low values to the highest obtainable are described. The use of thermocouples, the errors encountered in the use of both base metal and rare metal thermocouples, and the methods used to avoid these errors are discussed. Thermocouples are useful in measuring temperatures up to about 1000 to 1500°C. Beyond the range of thermocouples and sometimes even in this range it is necessary to use some means of measuring temperature that depends on the energy radiated from the source under consideration. For this class of work the optical pyrometer is recommended as one very good method.

Different forms of optical pyrometers are discussed and the advantages and disadvantages of these types are pointed out. The conclusion is reached that for many types of work the disappearing-filament type of optical pyrometer has certain advantages over other forms. Some of these advantages are pointed out and reasons given for the selection of this pyrometer. The necessity for the use of a monochromatic screen with a pyrometer is discussed and a list of the various screens available are given. Reasons are given for the general choice of a red screen for this work. In the use of an optical pyrometer it is at times necessary to know something concerning the wave-length of the light used. This brings up the question of the effective wave-length of the screen used. The effective wave-length is defined and methods given for determining and using this effective wave-length in optical pyrometry. It is shown that with a well-calibrated screen just as definite results can be obtained as with a spectrometer for determining wave-length, and the advantages of the screen over the spectrometer are set forth.

Methods of calibrating optical pyrometers are discussed which bring in the idea of a black body. Methods of realizing the theoretical black body are given together with some experimental results along this line.

The use of absorbing screens in extending the scale of an optical pyrometer is outlined and methods are given of obtaining the transmission of the absorbing screens so that it is easy to calculate the extension of the temperature scale with a particular screen. The kind of an absorbing screen needed for this work is shown and the advantages and disadvantages of the absorbing screens are given.

Accuracy tests are included in which it is shown that very good agreement can be obtained in the use of a disappearing-filament optical pyrometer by untrained or slightly trained observers. Results are also given to show what accuracy may be expected from experienced observers from this form of pyrometer.

In almost all industries, the problem of temperature and temperature measurement is encountered and in most cases very high temperatures are necessary. In heating anything there are two points to consider: first, the method of heating, and second, how hot it is heated. It is hard to say whether it is more important to be able to reach the desired temperature than to know when the temperature is just right for the purpose at hand. Of course, the first important thing is to be able to reach the desired temperature, but from present-day considerations the

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Glass Division.) Received June 7, 1929.

value of the product depends upon a knowledge of the temperature that is reached.

It might be well at this point to say something about what is meant by temperature. We all know in a general way when things are hot or cold. Using our hands we can arrange bodies in about their proper order as to their "hotness" or "coldness." This method will some times give wrong results. Two bodies are said to be at different temperatures if when they are brought together one loses heat and the other gains heat. The one that loses heat is said to be the hotter or to be at the higher temperature.

For accurate work a method of measuring temperature is necessary. In measuring temperature the same general method is adopted that is used in measuring any other physical quantity, that is, a basis of reference is chosen and the size of the unit defined. In this case the unit is defined as $^1/_{100}$ of the temperature interval between the freezing and the boiling points of water. There are several other scales in use, depending upon different divisions of this fundamental interval, but for scientific work the centigrade degree defined above is used. The magnitude of the degree at different points on the scale will, in general, depend upon the method used in measuring the temperature in this interval; thus it has been decided to define the temperature in terms of the change in pressure of a constant-volume hydrogen thermometer under specified conditions.

The standard scale that is aimed at for all temperatures is Kelvin's thermodynamic scale which does not depend upon the properties of any substance. This is the temperature scale that would be obtained with a gas thermometer using a perfect gas. The temperature scale obtained by a real gas can be corrected to the thermodynamic scale if the departure of the gas from a perfect gas is known. A good discussion of this is given by Buckingham,[2] where it is shown that the value that best fits all the experimental data for the ice point on the thermodynamic scale is 273.13° K. The corrections to the different gas thermometers are also given. These corrections have been worked out for temperatures up to 1200°K, and by extrapolation they have been extended to 2000°K, and are given in Table I. These corrections were calculated for an initial pressure on the gas of 1000 mm. of mercury. It was shown by Buckingham that "the thermodynamic correction of the centigrade constant-pressure scale at the given temperature is very nearly proportional to the constant pressure at which the gas is kept" and that "the thermodynamic correction of the centigrade constant-volume scale is approximately proportional to the initial pressure at the ice point." These two propositions are very useful, since after finding the corrections for any one pressure for a gas thermometer of either type, it is possible to calculate approximately the corrections for the same gas at any other pressure. In whatever

[2] Bur. Stand., *Bull.*, Vol. 3, p. 237.

TABLE I

CORRECTIONS TO CONSTANT-VOLUME AND CONSTANT-PRESSURE SCALE FOR NITROGEN
(All corrections to be added algebraically; pressure = 1000 mm. Hg)

Temperature (°K)	Constant volume	Constant pressure
173	−0.06	+0.34
273	0.0	0.0
600	+0.10	0.30
800	0.24	0.67
1000	0.42	1.08
1200	0.64	1.54
1400	0.86	1.98
1600*	1.1	2.5
1800*	1.4	3.0
2000*	1.7	3.5

* Extrapolated values.

manner the temperature is measured in practice, it is the thermodynamic scale that is aimed at.

The maximum temperature at which it is possible to use the gas thermometer is limited by the container for the gas. Day and Sosman, using a bulb of platinum rhodium alloy, carried the gas thermometer up to the melting point of palladium several years ago, and to date there has been indication of but a very small error at this high point, *i.e.*, an error of about twice what they set as their limit of error. For most work, however, the region of the gas thermometer would be considered to end at about 1000°C or 1273°K. Above this range temperatures are measured in terms of one of the radiation laws.

In order to secure a uniform temperature scale there has been a proposed international agreement[3] by representatives of various standardization laboratories in which standard values and methods have been agreed upon. According to this proposed international agreement the temperature scale has been divided into intervals according to the method used in measuring the temperature in the different intervals. The first interval is from −40 to 450°C and the temperature is to be measured in this interval by means of a platinum resistance thermometer. The second interval extends from 400 to 1100°C and the temperatures are to be measured with a platinum platinum-rhodium thermocouple. The third interval consists of all temperatures above about 1200°C and in this region temperatures are in general measured by some form of optical or radiation pyrometer.

The temperatures of the fixed points below 1100°C are now quite well known. Certain values have been decided upon by agreement for the standard fixed points below 1100°C. These, or course, represent the best experimental data available and are probably as accurate as can be obtained without a very great amount of additional work. Until better

[3] G. K. Burgess, Bur. Stand., *Jour. of Research*, **1**, 635 (1928).

TABLE II

STANDARD FIXED POINTS

Temperature	(°C)
Equilibrium between solid and gaseous carbon dioxide	−78.5
$t_p = t_{760} + 0.1443\ (t_p + 273.2)\ \log_{10}\ (p/760)$	
Freezing mercury	−38.87
Transition of sodium sulphate	32.38
Condensing naphthalene vapor	217.96
$t_p = t_{760} + 0.208\ (t_p + 273.3)\ \log_{10}\ (p/760)$	
Freezing tin	231.85
Condensing benzophenone vapor	305.9
$t_p = t_{760} + 0.194\ (t_p + 273.2)\ \log_{10}\ (p/760)$	
Freezing cadmium	320.9
" lead	327.3
" zinc	419.45
" antimony	630.5
" copper in a reducing atmosphere	1356.0°K
" palladium	1828.0°K
Melting tungsten	3655.0°K

are available therefore, the values given in this part of Table II should be used. The values in the region above this represent the best available data and are now very well known.

After the temperatures of the fixed points have been determined by one of the standard methods, *i.e.*, in terms of the gas thermometer, corrected to the thermodynamic scale, in the gas-thermometer region, or by the optical pyrometer or total radiation pyrometer in the region above this, there comes the difficulty of maintaining this scale both from the standpoint of the standardizing laboratory and the use of the temperature scale in the practical field. In the region of the platinum-resistance thermometer and the thermocouple, standards of either can be obtained from the standardizing laboratories and these used for checking up the regular instruments. It is not difficult actually to check up a resistance thermometer at any one of the standard points in the region −40 to 3450°C. It is a little more difficult to check up the thermocouple in the region 450 to 1100°C. Most of the standard fixed points in this region are given by melting points of metals that must be heated in such a way as to avoid oxidation. This requires a neutral atmosphere or that the sample be covered with some flux that will protect it.

It is not a difficult matter to measure temperature with a thermocouple; there are certain sources of error, however, that must be guarded against. To measure temperature with a thermocouple presupposes, of course, the proper equipment for the work. Such equipment is now available on the market, so well constructed by the makers that in general many of the difficulties are not encountered.

A thermocouple is such a common instrument that it seems hardly

necessary to say that it is made of two dissimilar metals so chosen that an e.m.f. will be developed when they are connected and one junction inserted into the furnace and heated to a temperature above the other junction which is kept at a constant temperature. There are a number of methods used in practice to maintain the cold junction at a constant temperature. The standard method is to mount this junction in an ice bath. If a thermos bottle is used for the ice bath it will remain at a constant temperature for a day or more without any attention after it has once been filled with ice. Another practical method of keeping the cold junction at a constant temperature is to bury it in the ground as there is very little change in the temperature of the ground for a depth of about ten feet, which makes this a satisfactory method for a permanent installation. The cold junction may be mounted in a protecting box and the temperature measured with a thermometer and the necessary corrections made. In addition, there have been a number of methods worked out for compensating for changes in the temperature of the cold junction. Some of these devices are on the market and when properly used are quite satisfactory.

The exact measurement of the e.m.f. developed by the thermocouple is important. There are several methods in use for this purpose, the standard one being to use the regular potentiometer equipment which is the method practically always used at a research or standardization laboratory. The potentiometer is not portable and requires some manipulation to make a reading; for these reasons some form of milli-voltmeter is generally used in practice. The milli-voltmeter should have a high resistance (300 to 1000 ohms) so that changes in the resistance of the external circuit will not cause too large an error, as would be the case with a low-resistance instrument. The couple develops a certain e.m.f. which causes a current to flow through the circuit including the voltmeter. This means that the e.m.f. is distributed in I. R. drop over the entire circuit. Thus, one or two ohms change in the resistance of the external circuit will cause a much larger error in the reading of the e.m.f. for a low resistance milli-voltmeter, that is, about 30 ohms, than for one of a high resistance. This error in the reading of the e.m.f. of course means an error in the reading of the temperature.

There are a number of instruments on the market designed to make it possible to read the exact e.m.f. of the couple similar to results found with the potentiometer and at the same time have the instrument portable. The deflection potentiometer, the pyrovolter, and the Brown heat meter are all instruments[4] of this kind. When carefully used they all work very well and give satisfactory results.

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[4] Pyrometer Symposium, A.I.M.M.E., pp. 85, 89, 90 (1920).

Under the best conditions, a thermocouple sooner or later becomes contaminated, which means that it must be replaced. The makers of thermocouple material have so standardized their couples that an old one may be replaced with a new one with almost inappreciable error. If the new couple does not read exactly the same e.m.f. as the old, there are methods for correcting this, such as a resistance either in series or in parallel with the milli-voltmeter.

The thermocouple must be insulated and also protected from the action of any materials inside the furnace. No hard and fast rule applies for all cases. There are a number of different insulators and protecting tubes on the market which for a great majority of the work are quite satisfactory. There are, however, a number of cases where a better insulator and better protecting tube would be of great benefit.

Sometimes not enough attention is paid to the depth of immersion of a couple. Due to heat conduction of the couple and the protecting tube, the junction of a couple may not be at the temperature it is supposed to measure. If a piece of platinum wire about 0.5 mm. in diameter is placed in a Bunsen flame it will get very hot but will not melt, although the temperature of the flame is known to be much higher than the melting point of platinum. This can be shown by holding a piece of platinum wire of very small diameter (about 0.05 mm.) in the flame. This wire will melt easily. Thus, it can be seen that a platinum thermocouple 0.5 mm. in diameter would not be a satisfactory instrument for measuring the temperature of a Bunsen flame. With a thermocouple made of No. 14 wire for accurate work several inches of the couple should be in the uniform part of the furnace to avoid errors due to end losses. This effect varies with the size and kind of wire used for the couple. There do not seem to be any data available on the heat conductivity of different thermocouple materials as a function of temperature from which calculations can be made of the error caused by different lengths of the couple being immersed in the uniform part of the furnace.

Base-metal thermocouples may be used up to about 1000°C, and platinum platinum-rhodium thermocouples may be used up to 1400 to 1500°C. Beyond this some other form of couple must be used. Some work has been done with carbon graphite couples and with tungsten molybdenum couples. A great disadvantage is that they must be protected from an oxidizing atmosphere which greatly reduces their usefulness.

A thermocouple is calibrated in much the same manner as an ordinary thermometer, that is, the couple, properly protected, is inserted into a furnace or bath which is maintained at a known temperature and the e.m.f. developed is measured. As shown above, there are a number of standard temperatures that can be used for this calibration. All the precautions

mentioned under the use of a thermocouple should be taken and in addition the material used as a standard temperature should be properly used and protected. The methods of using the standard temperatures are described in any good textbook on the subject and will not be gone into here. Dr. Adams of the Geophysical Laboratory[5] has outlined a simple method of working up the calibration of a thermocouple. He has tabulated the e.m.f. temperature relations for a number of couples made of different materials. He has also shown how to plot a curve that shows the difference between the standard couple and the couple being calibrated, which is quite a help in calibrating.

When measuring ordinary temperatures, *i.e.*, below 1200°K, the instrument is generally placed in close contact with the body the temperature of which is desired. If the temperature of the source, however, is continually raised, a point is soon reached where no known substance will, in general, remain constant in any of its temperature-measuring properties if placed in direct contact with the source. It is also occasionally necessary to measure the temperature of a source that is so small or so situated that it would be very hard to bring the measuring instrument into direct contact with the source. When these conditions exist, advantage is taken of the well-known fact that all bodies, when at sufficiently high temperatures, send out radiation in amounts readily measurable.

Thus, in the region above 1200°K, there are two difficulties. The first is the necessity of reaching the high temperature in such a way that it can be controlled and measured, and in addition, there is the second difficulty of getting and maintaining the black-body conditions, since temperature in this region depends upon the radiation laws of the black body.

The high-temperature scale above 1300°K is based upon the brightness of a black body at the temperature of the melting point of some one or more selected metals. Owing to their convenience, both as to their freedom from oxidization and as to temperature of their melting points, gold and palladium are generally chosen. Both of these metals can be successfully melted in a platinum-wound black body furnace. This is a great convenience because the whole operation can be carried out in the open air, thus requiring no special precautions in maintaining either a vacuum furnace or a neutral atmosphere within the furnace. The black body at a particular temperature is the standard, whether the scale is determined by means of a total radiation or by means of an optical pyrometer. Most experimenters determine their temperatures in this region by means of an optical pyrometer.

For calibration at the palladium point, the thermocouple of platinum platinum-rhodium is not very reliable in that it will not remain constant

[5] Symposium on Pyrometry, *Trans. Amer. Inst. Mining Met. Eng.*, p. 165 (1920).

as it is used inside the platinum-wound furnace. This necessitates that each time a calibration is made the point be found by a melting-point determination. Any one who has used a black body for such purposes will know that this requires a great amount of work. Thus, while in the standardizing laboratory the scale should be maintained and checked by actual measurements from the black body at the standard melting point, some other method is necessary in practice. Much time can be saved if a tungsten lamp with a filament of suitable size is standardized so as to have the same brightness for a particular part of the filament, when observed with the optical pyrometer, as the standard black-body furnace for one or more definite temperatures. Such lamps with single-loop wire filaments have been made, calibrated, and used in this laboratory for this purpose for several years. The bend in the wire is made somewhat sharp and the center of this loop used as a point of reference. This method has recently been employed by a number of research laboratories in this country using lamps calibrated at several currents for temperatures between 1200°K and 2000°K.

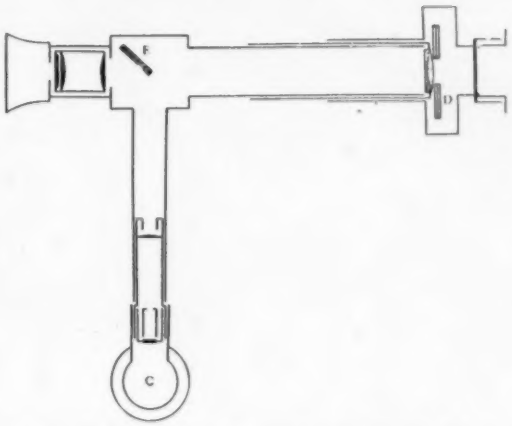

FIG. 1.—Diagram showing arrangements used in one form of Le Chatelier optical pyrometer.

The temperatures of very hot bodies have probably always been judged by the color or the brightness of the light given off. With practice, one can estimate probably within 50 to 100°C of the correct value. If judgment is left to the eye alone, however, much larger errors are sometimes made, due to the use that has been made of the eye just previous to the time of estimating. To secure accurate estimates by eye, a comparison source is necessary.

The introduction of a comparison source is the first step toward an optical pyrometer, which consists of a comparison source and some convenient arrangement for matching this source, either in brightness or in color, against the source studied. In Fig. 1 is shown diagrammatically the arrangement used in one form of the Le Chatelier optical pyrometer. The light from the comparison source at C is reflected into the eyepiece by a mirror, E, so arranged that one-half of the field is illuminated by light from the comparison source and the other by light from the source studied. The match is obtained either by varying the intensity of the comparison

source or by varying the size of the opening before the objective lens, D.

The disappearing-filament type of optical pyrometer is very simple in its construction, being practically a telescope in appearance (Fig. 2). It differs from a telescope in that it contains, for use as a comparison source, a lamp filament, called the pyrometer filament, which is located at the focus of the objective lens. In series with this filament is a small battery, a resistance, and an ammeter. To measure the temperature of any hot body with this pyrometer, the instrument is first sighted upon the hot body, which is done as easily and in much the same manner as the focusing of an opera glass. When looked at, the hot object is seen with the pyrometer filament crossing it, so that the filament appears much the same as the cross-hairs in an ordinary telescope. By varying the current, the brightness

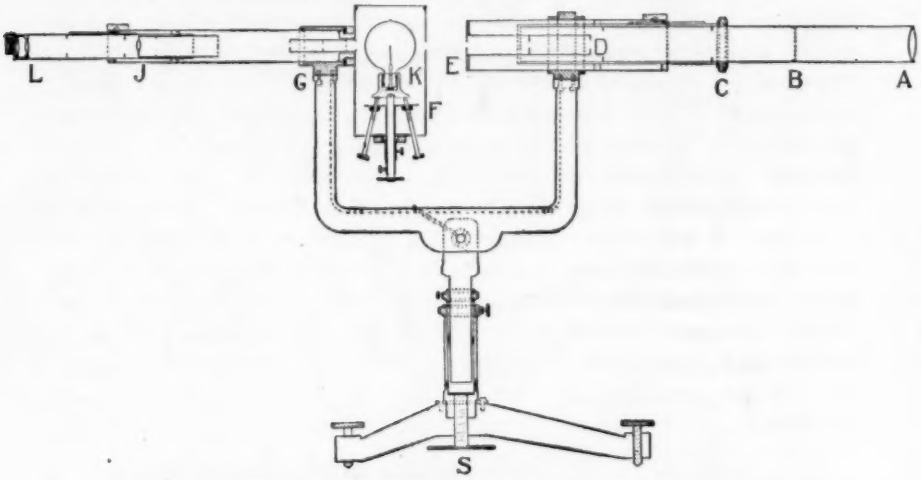

FIG. 2.—Diagram of a disappearing-filament optical pyrometer.

of the filament will change and it can be made to disappear against the image of the source studied. By mounting a piece of red glass in the eyepiece, it is much easier to tell when the brightness of the object sighted upon and the comparison source are the same.

There is another form of the disappearing-filament pyrometer designed by Foote and Fisher. In this form the filament is kept at a constant brightness which must be at as low a brightness as it is expected to use the pyrometer. Balances are made by means of an absorbing wedge between the pyrometer filament and the source being studied. The wedge is made in a circular form so that balances can be made by rotating a circular scale. The advantage of this form is that it can be made direct reading.

The disappearing-filament type of pyrometer possesses several advantages over other forms. In the first place, the observer is able to see the

object whose temperature is being measured directly through the pyrometer, the same as through a telescope. It is hard to overestimate this advantage. Often it is desirable to measure the temperature of a particular point of an extended body, as for instance, a mass of molten iron in the furnace or a particular spot on an ingot that is being rolled. This can be easily done with this pyrometer while it is very difficult with most other forms. For this reason, this form of pyrometer gives the temperature of a particular small area of the object whose temperature is being measured rather than an average over a more extended area. It is not necessary to have an extended source in order to measure its temperature. Some pyrometers require a source that is very large if the observer is at any distance; such is not the case with this form. Another advantage that is to be considered is the fact that this form of pyrometer is almost free from any error due to polarization. Any effect due to this cause would be negligible in almost the worst case possible.

In calibrating an optical pyrometer it is necessary to have a standard radiator at a standard temperature. The standard radiator is the black body, which has been defined by Kirchhoff as a body that will absorb all the radiation that it receives; that is, it will neither reflect nor transmit any of the incident radiation. He also showed that the radiation from such a body is a function of the temperature alone. There is no known substance that has exactly this property; the nearest approach is probably some form of untreated carbon. It has been shown theoretically that a cavity with walls at a uniform temperature possesses the properties of a black body. If, now, a small hole is made in the wall of the cavity the radiation from this hole will approximate that of a black body. The smaller the hole in proportion to the size of the cavity, the nearer this approximation.

Many attempts have been made to realize this uniformly-heated cavity with an opening through which the radiation can be studied. The one most commonly used for temperatures above 1000°K consists of a refractory tube more or less uniformly wound with platinum ribbon and containing a central and other diaphragms with small holes in them. For temperatures as high as the melting point of palladium (1828°K), it is necessary to have a second refractory tube outside of the first: this tube also is wound with platinum ribbon but the windings are spaced farther apart at the center than at the ends, in order to correct for the end cooling. Such a furnace with the space between these two heater tubes filled with pure aluminum oxide and with two tubes slipped inside of another tube that has been packed with a good heat-insulating material has been found to work very well. If this outside tube and its packing extend well beyond the ends of the heater tubes, the end cooling will be very much reduced. Such a platinum wound black-body furnace has

been heated to the temperature of melting palladium a dozen times and held at this high temperature for several hours each time, and is still in working order.

The equation that gives the temperature of the black body in terms of brightness for any color, *i.e.*, wave-length, has been worked out by Planck and is as follows:

$$E_\lambda = \frac{c_1 \lambda^{-5}}{\left(e^{\frac{c_2}{\lambda T}} - 1\right)}$$

For small values of the product λT, this reduces to the more simple form derived by Wien, $E_\lambda = c_1 \lambda^{-} \epsilon^{-\frac{c_2}{\lambda T}}$. In any form of optical pyrometry where the temperature of a black body is determined by a measurement of the brightness for a particular wave-length interval, the temperature is calculated from the brightness measurement by means of Wien's equation. One of the advantages of optical pyrometers can be seen by an investigation of this equation. For a particular wave-length interval (0.665μ) the brightness varies about eleven times as fast as the temperature for a temperature of about 2000°K. Wien's equation, which is hardly more than an empirical law, has been found experimentally to represent the facts quite accurately for such temperatures and wave-lengths for which the product λT is less than 3000. Thus for optical pyrometry where the longest wave-length is less than 0.7μ, the equation is valid and an instrument thus calibrated may be used throughout a wide range of temperature.

It is not absolute measurements of brightness that are made with the optical pyrometer, but rather comparisons of brightness, that is, the brightness of the unknown source is compared with that of a standard black body at a particular temperature. Using Wien's equation in this way requires but the one constant, c_2. The value of c_2 that fits best all the different experimental data[6] is $14{,}330\mu°$. The value generally accepted for the melting point of gold is 1336°K, which is the value found by Day and Sosman.[7] This value for the gold point, together with the above value of c_2, leads to 1829°K as the palladium point.

As the wave-length enters in the equation for calculating the temperature from the brightness measurements, it is necessary to have some means of obtaining a definite wave-length, *i.e.*, definite color. This can be done very well by the use of a spectrometer, but fortunately this is not necessary. It will be shown that it is generally sufficient to use a so-called monochromatic screen between the eye and the pyrometer filament, or other comparison source, in order that brightness comparisons can be made without trouble due to color differences. For the most part red-

[6] Coblentz, U. S. Bur. Stand., *Bull.*, No. 13, p. 470.

[7] *Amer. Jour. Sci.*, **29**, 93 (1910).

glass screens have been used rather than blue screens, or those having a transmission band near the central part of the visible spectrum for the following reasons: (1) At low temperatures, the red radiation first becomes visible and thus readings may be made at a somewhat lower temperature with the red glass. (2) The color change for a change in wave-length is much less in the red part of the spectrum than in the green, which makes the red the better part of the spectrum for this work. (3) Better monochromatism can be obtained in glass of this color by using a red glass. (4) By using a red screen when measuring a temperature so high that a rotating sector or absorbing glass is necessary, the transmission of the sector or absorbing glass that must be used to reach a particular temperature is greater for the longer wave-length than it is for the short wave-length. Colored glass to be suitable for a monochromatic screen must have a rather narrow transmission band, in order that there will not be enough color difference between the source studied and the comparison source to prevent accurate comparisons from being made. As there may be more than 1000° difference in temperature between the sources compared, this is very important.

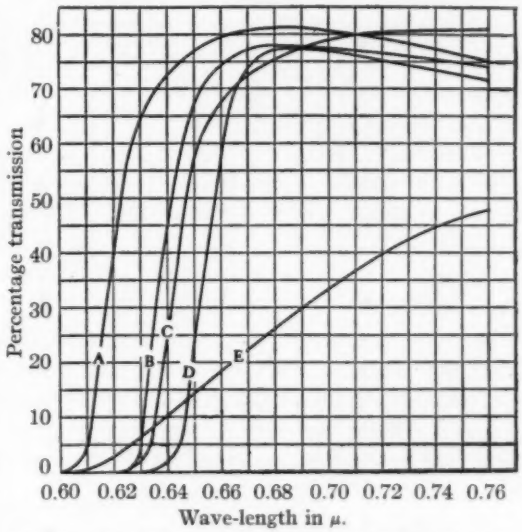

FIG. 3.—Spectral transmission of various red glasses.
Curve C for Jena red 4512, 2.93 mm. thick.
Curve E for Jena red 2745, 3.2 mm. thick.
Curve A for Corning high transmission red, marked 150%, 5 mm. thick.
Curve B for Corning high transmission red, marked 50%, 5 mm. thick.
Curve D for Corning high transmission red, marked 28%, 6 mm. thick.

In Fig. 3 are shown the spectral transmissions of several red glasses that are nearly enough monochromatic for use under various conditions. The glass having the spectral transmission shown by curve A does very well for a commercial pyrometer for low temperature ranges because the amount of light transmitted is so great. The glass having the transmission shown by curve E was formerly used for this purpose. As the effective wave-length (see below) for this glass varies about twice as much as for the other glasses, it is not as satisfactory. The glasses having the transmission shown by curves B, C, and D are suitable for the most

accurate work. To test the constancy of the spectral transmission of the red glass, a piece of the Corning red 50% glass, curve B, the transmission of which had been carefully measured, was placed on the roof of the laboratory where it was exposed to the direct rays of the sun for a little more than a year; when it was brought in no change was found in its spectral transmission. Evidently then, the spectral transmission of such glass is constant for all ordinary uses.

An optical pyrometer can be so calibrated and so used as to make unnecessary a knowledge of the extent to which the screen is monochromatic. To do this requires a black-body furnace that can be operated at various temperatures up to the highest temperature for which the pyrometer is to be used. To use Wien's equation, however, to extend the temperature scale either above or below that of the standard furnace by the use of rotating sector disks or absorbing glass, that is, to find the temperature of a black body having a brightness of ten times (assuming a sector or absorbing glass transmission of one-tenth) that of a black body whose temperature can be measured directly, a knowledge of what wave-length to use or the effective wave-length is necessary. The effective wave-length also must be known if the pyrometer is used to measure the temperature of non-black bodies.

In using the pyrometer, it is the integral luminosities through the red glass that are compared, for which reason the effective wave-length of the red glass screen for a certain temperature-interval has been defined as the wave-length for the definite temperature-interval for a black body, such that, the ratio of its radiation intensities equals the ratio of the integral luminosities through the screen used.

Knowing the spectral transmission of the red glass, it is possible to calculate the effective wave-length, λ_e, for any temperature-interval by means of the following equation:

$$\frac{\int J(\lambda T_1) V_\lambda t_R d\lambda}{\int J(\lambda T_2) V_\lambda t_R d\lambda} = \left(\frac{J(\lambda T_1)}{J(\lambda T_2)}\right)_{\lambda_e} \qquad (1)$$

where $J(\lambda T)d\lambda$ is the energy, as given in Wien's equation, for the wave-length interval from λ to $\lambda + d\lambda$; t_R is the spectral transmission of the red glass; and V_λ is the visibility. These integrals can be computed by the step-by-step method with sufficient accuracy for this purpose. Using equation (1), the effective wave-length was calculated for the red glass having the spectral transmission shown by curve B, Fig. 3, for a number of temperature-intervals and plotted, as shown in Fig. 4. By connecting the points where the curve for the effective wave-length from any particular temperature crosses the same temperature ordinate, a curve is obtained (E, Fig. 4) that gives the limiting effective wave-length for a particular temperature.

To show how these curves may be used, the effective wave-length for a couple of temperature-intervals will be found. The effective wave-length between 1800°K and 2900°K is given by the ordinate of the point where the 1800°K curve crosses the 2900°K ordinate, that is, it is 0.6587μ. For the range between 2100°K and 2900°K, the effective wave-length is likewise given by the point where the 2100°K curve would cross the 2900°K ordinate. The 2100°K curve is not drawn, but will have to be imagined as being parallel to the 1800°K, one point of its position being determined by where the curve E crosses the 2100°K ordinate. The

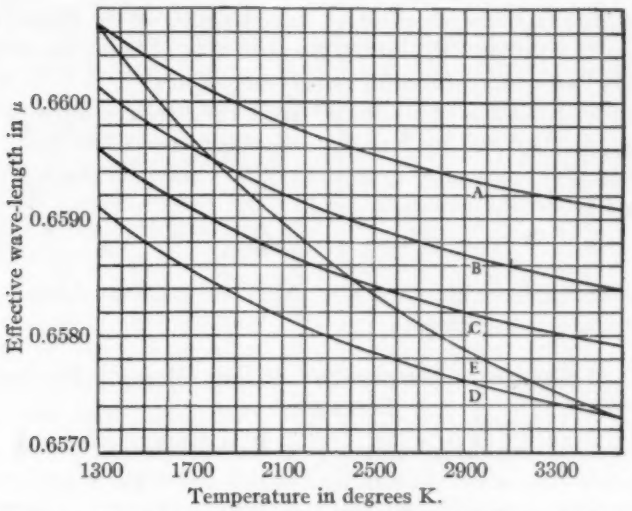

FIG. 4.—Effective wave-lengths for Corning Red Glass. Spectral transmission shown by Curve B, Fig. 6.

Curve A: effective wave-lengths from 1300° to other temperatures.
" B: " " " " 1800° " " "
" C: " " " " 2400° " " "
" D: " " " " 3600° " " "
" E: limiting effective wave-length.

effective wave-length for this interval is 0.6584μ. It can be seen from the figure that the effective wave-length for any temperature-interval is given quite closely by the mean of the limiting effective wave-length for the two temperatures.

To determine the effective wave-length for a particular red glass requires considerable work both in determining the spectral transmission and in calculating the final values. To determine the effective wave-length for every glass used in optical pyrometer would be laborious. It is fortunately possible to obtain the effective wave-length of an unknown piece of glass in terms of a standard red glass with very few measurements.

If the relative brightness of a black body for two temperatures is measured both with the standard red glass and the glass being investigated, it is possible to compute the effective wave-length of the unknown glass from that of the standard red glass and the ratios of the black-body brightness thus found. From the definition of the effective wave-length and Wien's equation, the following equation is found connecting the effective wave-length and the ratio of the black-body brightness:

$$\frac{(\lambda_e)_a}{(\lambda_e)_x} = \frac{\log B_x}{\log B_a} \qquad (2)$$

where $(\lambda_e)_a$ and $(\lambda_e)_x$ are the effective wave-lengths for the glasses a and x for the range studied and B_a and B_x, the ratio of the brightness of the black body for the two temperatures for red glasses a and x.

Experimentally it has been shown that if the effective wave-lengths are determined for two red glasses that have somewhat the same spectral transmission, the relation between the effective wave-length is given quite approximately by the equation:

$$(\lambda_e)_a = (\lambda_e)_x + \text{constant} \qquad (3)$$

This equation holds for the glasses investigated to all the accuracy needed for temperature measurements.

Effect of Change of Temperature of Red Glass on Its Spectral Transmission

In connection with the investigation of the effective wave-lengths it was observed that the transmission of the red pyrometer glass, presumably dependent for the color on a colloidal solution, is subject to a large change with temperature. This has not been investigated thoroughly, but observations were made at two temperatures, 20°C and 80°C, by immersing the glass in water heated to these temperatures. The results are given in Fig. 5. Curve A is the transmission of the glass at the lower temperature, 20°C, and curve B the corresponding curve at the higher temperature, 80°C. The transmission is shown to decrease with increase in temperature, the coefficient of change of temperature being greatest in the shorter wave-lengths. The change is such as to make the transmission band appear to shift to longer wave-lengths as the temperature is increased.

A test was made of the effect of this temperature shift of the transmission band on temperature measurements when the red glass was used as a screen before the eyepiece of the pyrometer. The temperature of a broad carbon filament lamp operated at a brightness temperature of 1900°K was measured with the red glass at room temperature (20°C) and at 80°C using a sectored disk with a 2° opening, since this would give a larger effect than a sector with greater transmission. It was found that there

was a decrease of about 5°C in the temperature obtained when the glass was heated to 80°C over that obtained with the glass at room temperature. This shows that for all ordinary temperature changes, the effect is negligible.

Use of an Optical Pyrometer It often happens that when it is necessary to measure the temperatures of a hot radiating body with an optical pyrometer the operator does not know just how to proceed. Although optical pyrometers are readily purchasable, if it is necessary to construct one, it will usually be much easier to build one of the disappearing-filament type. All that is required for this is an objective lens about 3 cm. in diameter and about 25 cm. focal length, a piece of red glass, a long focus eyepiece, and a battery.

An ordinary spectacle lens of the right focal length can be used for the objective lens and two such lenses of the proper focal length will do for the eyepiece. For ordinary work it is not necessary to have achromatic lenses since a red glass is used on the eyepiece. The optical parts may all be mounted on some sort of an optical bench or if they are to be used permanently, it is well to have them mounted inside of a tube after the manner of a telescope. The pyrometer lamp is to be so mounted with respect to the objective lens that an image of the source being investigated can be brought to a focus in the plane of the filament and this image and the pyrometer filament both observed through the eyepiece. When using this instrument, the different parts are adjusted so that the images of both the source being investigated and the pyrometer filament are as well defined as possible. The arrangement of the different parts of the disappearing-filament optical pyrometer is shown in Fig. 2. The particular way in which the pyrometer is built depends upon the purpose for which it is intended. If it is desired to measure the temperature of a large source, it will not be necessary to have very large magnification. The distances between the pyrometer lamp and the eyepiece depend upon the focal

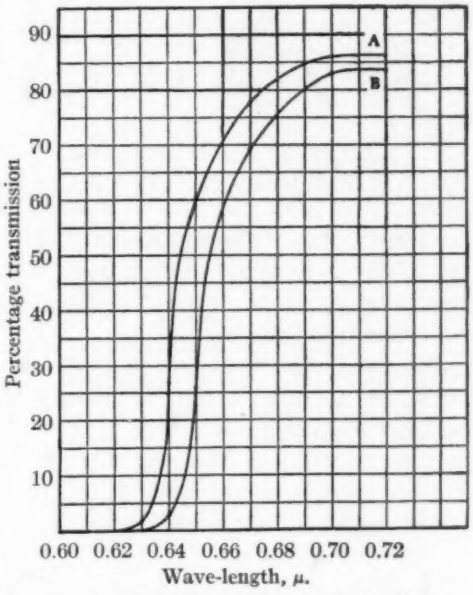

FIG. 5.—Spectral transmission of a single thickness of glass F–4512; A at 20°C; B at 80°C.

length of the lens in the eyepiece F (in the case illustrated in the figure, a telescope of short focus). The main requirement is for the image of the source in the plane of the pyrometer filament to be much larger than the pyrometer filament, since it has been found by experiment that accurate matches cannot be made unless the background image is somewhat larger than the pyrometer filament.

Pyrometer Filaments Some care is required in the selection of the pyrometer filament. Carbon filaments are quite satisfactory for low temperatures but they will not have a very long life if operated at a high temperature. Tungsten pyrometer filaments are just as good as carbon filaments and have a long life if not operated at a brightness above that necessary to match a black body at the temperature of melting palladium (1828°K). They are often constructed with a small bend at the exact point where the filament is to be observed. A small point is sometimes used to help locate the exact spot. The $2^1/_2$ mil. (0.063 mm.) filaments require about 0.46 amperes to apparently match in brightness the black body at the temperature of melting palladium. One lamp that has been in use almost every day for about two years, when first calibrated required 0.4573 amperes to apparently match the black body at the temperature of melting palladium; after about two years of use, it required 0.4578 amperes. This difference in current corresponds to less than 1.5°C.

For the highest accuracy an ammeter is not accurate enough for measuring the current through the pyrometer filament. Some form of potentiometer must be used. If the same potentiometer is used to measure the current through the lamp being studied and the pyrometer a great deal of time is wasted in changing the potentiometer for each reading. A good method, which is at the same time quite accurate, is to use the deflection potentiometer principle. The regular Leeds and Northrup potentiometer lends itself quite readily to such adaption. By connecting a milli-voltmeter or a galvanometer of the proper sensitivity in series with the standard resistance and between the binding post marked *Br* and a traveling plug inserted in the proper place on the dial, pyrometer currents can be read to one part in three of four thousand very easily. The readings can thus be made very rapidly and at the end of the set these same readings can be checked on the potentiometer. This makes the current readings practically independent of the constancy of any deflection instrument. With a switch in this millivoltmeter line, the potentiometer is left free to check any other current, such as the one through the lamp that is being investigated.

Calibration of Optical Pyrometers Despite all that has been written about the calibration of an optical pyrometer, a question is often asked concerning the starting point for

the calibration of the pyrometer. To make a completely independent calibration of any pyrometer would be a great undertaking. Fortunately, it is not necessary or desirable that each one should make an absolutely independent calibration. If one has to calibrate an ordinary mercury thermometer at about 100°C, it would be calibrated by immersing the thermometer in steam. If a higher point was wanted some material with a melting or boiling point in the proper region might be used, and the calibration made at the melting or boiling point as the case might be. The temperature of boiling water is defined as 100°C but the temperature of the other points in this region are used with just as little question and with just about as much confidence as this one. To probably a lesser extent the same condition exists at high temperatures. The temperature of either melting gold or palladium is constant and is well known. It only remains to bring the standard radiator, that is the black body, to either one of these definite temperatures and from this to calibrate the pyrometer. In this case, the pyrometer filament is matched in brightness with the image of the black body across which it is seen through the eyepiece of the pyrometer.

When a furnace is used as a standard of radiation for calibration of an optical pyrometer, it is held at either the temperature of melting gold or melting palladium. In order to be sure that the furnace is at the temperature desired, a sample of the metal is melted inside the furnace. To do this the sample of gold or palladium is mounted between platinum wires supported by two refractory tubes and the circuit completed through a battery and bell or other indicating instrument. It is necessary to mount the specimen in such a manner that the central part of the sample cannot touch either of these two tubes, as it has sometimes been found that if a single tube is used the melted metal will touch and cling to the end of the tube so that the electric circuit is not broken at the instant of melting and thus a high value is obtained. With the central part of the sample free, it is assumed that the circuit is broken at the instant of melting. When a melt is obtained, the furnace is held at this temperature using as an indicator the e.m.f. of the thermocouple, and then a number of readings made with the optical pyrometer sighted upon the black body. Another melt is then obtained and the process repeated. This procedure is necessary because it has been found that the e.m.f. of a platinum platinum-rhodium thermocouple changes constantly when used at the high temperatures unless the most exceptional precautions to eliminate impurities in its manufacture and to prevent contamination during use have been taken.

The standard radiator at the standard temperature gives one point on the calibration. To obtain another point, readings are taken of the current through the pyrometer filament for an apparent brightness match with a rotating sector, or absorbing glass of known transmission, between the

pyrometer lamp and the standard black body. This will give a measure, in terms of the pyrometer current, of a brightness that is some known fraction of that of the standard radiator at the standard temperature. If monochromatic radiation is used, it is easy to calculate the temperature, T_2, of the black body corresponding to this current through the pyrometer filament, that is to this measured brightness, from T_1 the standard temperature by the following formula derived from Wien's equation:

$$\frac{1}{T_1} - \frac{1}{T_2} = \frac{\lambda \cdot \log R}{c_2 \log e} \qquad (4)$$

where R is the transmission of the sector, and λ is the wave-length used. If the measurements are made with a red glass in the eyepiece, the temperature that would correspond to this fraction of the brightness of the standard black body can be calculated just as before, excepting that in this case the effective wave-length of the red glass for the temperature interval is to be used.

Extending Temperature Scale

If a rotating sector or an absorbing glass of known transmission is used between the source being investigated and a calibrated pyrometer lamp, temperatures higher than that of the standard black body can be measured. In this case, the temperature is to be calculated from the temperature corresponding to the current through the pyrometer filament and the transmission of the sector or absorbing glass used by means of equation (4) above, except in this case for R, use the reciprocal of the transmission of the sector or glass, and then T_2 will come out greater than T_1. A convenient method is to work out such extrapolated temperatures for the various sectors and absorbing glasses that are to be used, and plot the extrapolated temperatures against the temperatures as determined from the pyrometer reading. Such curves can then be used with any pyrometer using the same red glass, providing the same sectors or absorbing glasses are used.

Wien's equation is generally used to calculate temperatures from brightness measurements. This equation does not fit the experimental evidence excepting for small values of the product λT. Table III has been prepared to show just what errors are obtained in the use of this equation

TABLE III

CORRECTIONS TO BE ADDED TO TEMPERATURES OBTAINED FROM WIEN'S EQUATION TO REDUCE THEM TO WHAT WOULD BE OBTAINED FROM PLANCK'S EQUATION

Temperature °K	Corrections to True Temperature
2000	− 0.01
2600	− 0.05
3000	− 0.3
3600	− 1.5
5000	−15.6

rather than Planck's more exact form. The results for true temperature were obtained by calculating the higher temperature from 1828°K and wave-length of $\lambda = 0.665\mu$.

From Table III it can be seen that Wien's equation is quite satisfactory for temperatures up to about 3600°K, since the error obtained by its use is less than the experimental error.

It has been found in photometry that two adjacent surfaces can be brought accurately to the condition of the same brightness by eye observations if there is no visible line separating them. If the disappearing-filament pyrometer is properly lined up and the proper magnification and resolving power is used, there will be no visible line separating the pyrometer filament from the image of the background; thus the conditions for brightness matches are good. If properly adjusted the polarization type of pyrometer has a good field since the line separating the two parts disappears entirely. Other types of pyrometers can be so constructed that the line of separation between the two parts is quite satisfactory.

Dependence of the Temperature on Various Conditions

(*a*) *The Constant* c_2. The value of c_2 that seems to fit all the experimental data is $14{,}330\mu°$. In calculating temperature from brightness comparison the results obtained depend upon the value of c_2 used. Temperatures are in general calculated from a standard temperature using Wien's equation. From this equation the following relation is obtained between two temperatures, T'_2 and T_2 obtained by use of two different values for c_2, from an initial temperature T_1, and from a particular ratio of brightness and wave-length λ:

$$\frac{1}{T_2} - \frac{1}{T_1} = \frac{c'_2}{c_2}\left(\frac{1}{T'_2} - \frac{1}{T_1}\right) \tag{5}$$

Using this equation with $T_1 = 1336$°K (gold point), the corrections were calculated for various temperatures and various values of c_2. From such relations a temperature corresponding to a particular c_2 can be corrected to any desired value of c_2. Suppose that a temperature of 2500°K is found for $c_2 = 14{,}350$ and the correction is desired for $c_2 = 14{,}200$. From the curve marked 14,200, the correction for 2500°K is seen to be +25°. Thus the temperature should be 2525 for $c_2 = 14{,}200$.

(*b*) *Brightness.* A very great advantage of the optical pyrometer in measuring temperature is due to the relation between a change in the brightness and the corresponding change in temperature. At 1000°K for red radiation ($\lambda = 0.665\mu$), the brightness varies about 22 times as fast as the temperature. At 2000°K for red radiation the ratio is about 11. From Wien's equation the following is the relation between the change in energy and the change in temperature:

$$\frac{dE_\lambda}{E_\lambda} = \frac{dTc_2}{T\lambda T} \tag{6}$$

The relation between a change in temperature and the corresponding change in brightness for the red ($\lambda = 0.665\mu$), green ($\lambda = 0.57\mu$), and blue ($\lambda = 0.475\mu$) has been computed for temperature ranges, and the results plotted as shown in Fig. 6. From these curves the ratio of the change in brightness to the change in temperature for any of the three wave-lengths and any temperature can be found. For example, at a temperature of 2500° for $\lambda = 0.57$, the brightness changes about ten times as fast as the temperature.

When measuring the temperature of a source with an optical pyrometer

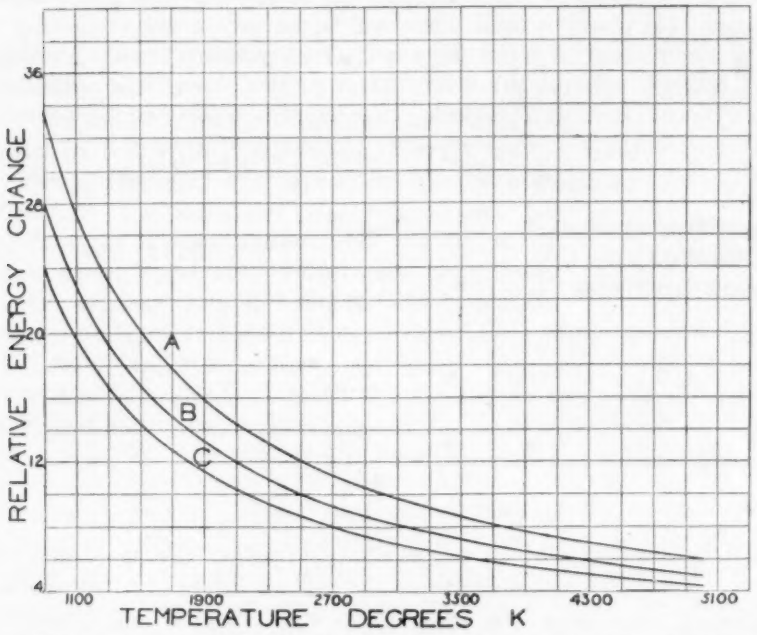

FIG. 6.—Curves showing the relative change in energy for per cent change in temperature curve A, for blue ($\lambda = 0.475$); curve B for green ($\lambda = 0.57$); curve C for red ($\lambda = 0.665$).

there are some precautions that should be taken. Fortunately the maker of the pyrometer has been able to take care of some of these in the construction of the instrument.

(*c*) *Clean Optical Parts.* The first thing to keep in mind is that it is a calibrated instrument and must be handled as such. All the optical parts of the instrument should be kept clean. The actual error due to dirt on the objective lens is not very great. A lens has to be very dirty to cause an error of 10° at 1500°K. Errors much larger than this, however, are possible if the lenses are allowed to become dirty. An error of 15° at 1500°K would be caused by allowing the lens to become so covered

with dirt that its transmission would be reduced to 85% of its value when clean. If the lenses and pyrometer lamp bulb are allowed to become dirty, it interferes with the clearness of the images and thus lessens the accuracy of the setting. They should be kept clean, but in cleaning them care is required or scratches will be produced which will again interfere with definition.

(*d*) *Comparison Source.* Great care must be taken not to change the comparison source in any way. In some pyrometers even the position of the comparison lamp must not be changed. In the disappearing-filament type small changes in the position of the part of the filament under observation will cause no appreciable error. In no case must the filament be overheated, since this may greatly change its characteristics. The pyrometer lamp of tungsten, if not used at a temperature higher than 1828°K will have a very long life. The lamps have been aged for a considerable time at a temperature much higher than this, so a current somewhat above that for which it is calibrated will not change its calibration. A good plan is to allow no current higher than that for which it has been calibrated to pass through the filament.

Accuracy Tests A number of experiments were made to test out the accuracy that might be expected in the use of the disappearing-filament type of optical pyrometer. In the first experiment, readings were made by a number of observers who had no experience in this kind of work; in the second experiment readings were made by experienced observers. The instrument used in each case was the laboratory form of pyrometer shown. The resistance that controls the current through the pyrometer filament was so chosen that the sliding contact had to be moved quite a distance in order to change the apparent brightness of the filament by an appreciable amount. The current was measured by means of a potentiometer.

In Table IV are given the results of the first experiment. Observers 1 and 2 were high-school graduates with several months' experience as laboratory assistants. Observer 3 was a man with several years' experience in shop work. Observer 4 was a man with several years' experience in a

TABLE IV

RESULTS OBTAINED WITH A DISAPPEARING-FILAMENT TYPE OF PYROMETER BY INEXPERIENCED OBSERVERS

Observer	Value obtained for temperature, as an average of six readings, (°K)		Variation of single readings from mean (°K)
Standards	1438	1643	
(1) L.C.	1439	1643	4
(2) H.W.	1438	1642	3
(3) F.G.	1439	1642	2
(4) E.H.	1436	1644	3
(5) E.W.	1436	1636	5
(6) L.R.	1436	1640	2

lamp factory. Observers 5 and 6 were girls from the lamp factory; No. 5 had no experience with this kind of work, while No. 6 had had experience with the photometer.

The table shows that but a single observer made an error greater than 3°K in the temperature as obtained from the average of six readings. In no instance was a value of temperature obtained from a single reading that differed more than 5° from the mean of the set of readings. These results are thought to be very good and to indicate the character of results that could be obtained with this form of pyrometer in industrial work. The pyrometer used probably enabled the observers to make much more accurate observations than is possible with a commercial form of the instrument. Even a commercial instrument, however, could be so constructed that good observations could be obtained. In this work, as in almost all work depending on eye observations, a small amount of training makes a great improvement in the accuracy of the results.

The second experiment was more extended and had as an object to test out the constancy of readings of different observers when using a sectored disk of low transmission or a dense absorbing glass to cut down the apparent brightness of a source studied. The observers who made these readings obtained very nearly the same readings when using the pyrometer directly; that is, with no sector or absorbing glass.

In this experiment, first with two pieces of Jena red glass No. 4512 (spectral transmission shown by curve C, Fig. 3) and second with two pieces of Corning red 50% (spectral transmission shown by curve B, Fig. 3) in the eyepiece of the pyrometer, readings were made on the apparent brightness of a particular source as observed through a rotating sector with two 1° openings, the Noviweld absorbing glass having the spectral transmission shown by curve C, Fig. 8, and through two pieces of Jena absorbing glass having the spectral transmission shown by curve B, Fig. 8. The source used was a 15-mil. tungsten lamp operated at a color temperature of 2610°K. The brightness was measured in terms of the current

TABLE V

RESULTS OBTAINED BY EXPERIENCED OBSERVERS USING DIFFERENT RED GLASSES AND DIFFERENT ABSORBING GLASSES

Observer	Red glass used	Current through pyrometer filament for apparent brightness match with: Direct	2° sector	Noviweld absorbing glass	Two Jena absorbing glasses
I.A.V.	Jena No. 4512	0.4343	0.3358	0.3804	0.3547
K.H.M.	" " 4512	0.4343	0.3361	0.3807	0.3546
W.E.F.	" " 4512	0.4343	0.3361	0.3803	0.3546
A.G.W.	" " 4512	0.4343	0.3358	0.3805	0.3547
I.A.V.	Corning Red		0.3380	0.3784	
K.H.M.	" "		0.3380	0.3785	
W.E.F.	" "		0.3380	0.3783	
A.G.W.	" "		0.3378	0.3784	

through the pyrometer filament for an apparent brightness match. Four observers made the measurements, three of whom had had considerable experience with this kind of work. Values of the current through the pyrometer filament thus obtained are given in Table V. The maximum range with the two glasses occurs for K.H.M. and W.E.F. for the Noviweld glass when the Jena red No. 4512 was used. This amounted to about 1% in brightness and to less than 5° in temperature at about 2500°K.

The visibility curves of the four observers are quite different. Two of the observers (I.A.V. and K.H.M.) are quite blue-sensitive, one (W.E.F.) is somewhat red-sensitive, and the other (A.G.W.) is very red-sensitive. From this, it is to be expected that different observers will get very closely the same values of brightness if they are limited to the extreme red. For the currents given in Table V, a change of 0.0005 ampere corresponds to a change of about 1% in brightness of the background. This same change in current through the pyrometer filament corresponds to about 3°K in temperature at about 2500°K.

Another experiment shows what results are to be expected with the optical pyrometer. The temperatures of several tungsten lamps were carefully measured in this laboratory for different currents and sent to the Bureau of Standards, the Physical Laboratory of the University of Wisconsin, the National Physical Laboratory of England, and the Research Laboratory of the General Electric Company at Schenectady, where the temperatures were measured for the same currents. The lamps were then returned to this laboratory for a second check on the temperatures. This gave an intercomparison of the temperature scales that are in use in different laboratories.

In each of the laboratories, the temperatures were measured by means of a disappearing-filament optical pyrometer using red glass as the mono-

TABLE VI

RESULTS OF INTERCOMPARISON OF TEMPERATURE SCALES

c_2 = 14350μ deg.: λ = 0.665μ: melting-point of Au = 1336°K (pd. = 1828°K)

Lamp	Current	N.R.L. (Oct., 1916)	G. E. Lab. Schenectady	N.R.L. (Nov., 1916)	Bureau of Standards	N.R.L. (April, 1917)
T-30-C	15.3	1813	1813	1813	1814	1813
	21.0	..	2307	2304	2302	2303
	27.5	2756	2752	2752	2762	2752

Lamp	Current	N.R.L. (March, 1916)	Univ. of Wisconsin C.E.M.		Univ. of Wisconsin G.R.G.	N.R.L. (July, 1917)
T-18-C	6.7	1599	1602		1605	1597
	8.8	1806	1816		1819	1807
	12.0	2105	2119		2123	2107

Lamp	Current	N.R.L. (April, 1920)	N.P.L. (April, 1922)	N.R.L. (June, 1922)	Bureau of Standards	N.R.L. (Jan., 1923)
T-78-C	15.4	1825	1825	1826	1824	1828
	20.4	2262	2265	2266	2265	2269
	27.4	2746	2757	2753	2755	2755

chromatic screen. As the different laboratories used a red glass having a slightly different effective wave-length, a small correction was necessary to reduce the temperature to the same wave-length. Such a correction would have been unnecessary if the sources whose temperatures were measured had been black bodies. A summary of the results, using the data on but three of the six lamps, is given in Table VI; the data obtained on the other three lamps are about the same.

Of the lamps used, all except one had flat filaments about 3 cm. long and about $1^1/_2$ mm. wide. The exact point at which it was desired to have the temperature measured was indicated either by a pointer, a notch in the supporting lead, or a small notch in the filament itself. Three of the lamps were gas-filled and two were of the vacuum type; the other lamp, which was gas-filled, had a 20-mil. (0.5-mm.) filament in the shape of a hairpin loop. As the loop was rather sharp, the exact point at which it was desired to have the temperature measured was easily indicated.

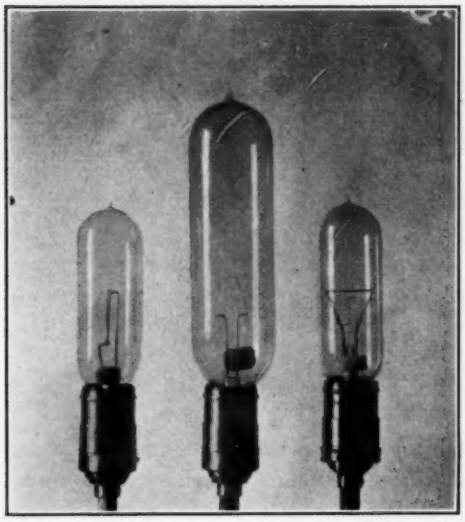

FIG. 7.—Lamps used in intercomparison of temperature scales.

In Fig. 7 is shown a picture of three of the lamps used in this temperature intercomparison. The flat-filament lamps have been quite useful in intercomparing the calibration of pyrometers and in calibrating a pyrometer. Such a lamp has been used as a source for work with the spectroscope. The high intensity attainable, together with its size and the fact that it will remain so constant, makes it a good source for this kind of work.

The table shows that the results by the Bureau of Standards, Research Laboratory of the General Electric Company, Schenectady, the National Physical Laboratory of England, and the Nela Research Laboratory agree very well for the entire range studied. The results obtained in the Physical Laboratory of the University of Wisconsin do not agree quite so well, but even here the differences are quite small.

Absorbing Screens for Optical Pyrometry

A sector that has been very carefully calibrated, if used properly is without doubt the best means that can be used for cutting down the apparent

intensity of a source that is being studied. In a research or a standardizing laboratory, the rotating sector is thus a valuable instrument. For commercial work, however, where a portable instrument is desired, a rotating sector adds to its size and makes necessary another source of power to drive the sector, so for a commercial pyrometer absorbing glasses are generally used, and when properly calibrated and properly used are very satisfactory.

When it is necessary to use glass-absorbing screens to reduce the apparent brightness of the source studied, the main requirement is to have a screen that approximates a neutral tint screen sufficiently well to enable comparisons in brightness to be made by different observers with the same results. The degree to which it is necessary for the absorbing screen to have a spectral transmission independent of the wave-length depends on the so-called monochromatic glass used in the eyepiece. It is quite evident that if this eyepiece glass is absolutely monochromatic, any absorbing glass will answer.

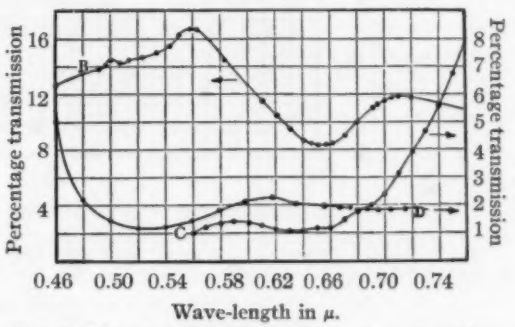

FIG. 8.—Spectral transmission of various absorbing glasses.

Curve B: Jena absorbing glass 1.5 mm. thick.
Curve C: Noviweld obtained from Corning Glass Works. Shade about 6.
Curve D: Leeds & Northrup absorbing glass made of purple and green glass.

In Fig. 8 are shown the spectral transmissions of a piece of Noviweld (curve C) and of a piece of Jena absorbing glass (curve B). Either of these glasses is nearly enough neutral tint for use with the red glasses having transmission curves shown by B, C, and D in Fig. 3. The Noviweld absorbing glass and the samples of Corning high-transmission red glass were obtained from F. P. Gage of the Corning Glass Works, Corning, N. Y. This absorbing glass is made in different shades with transmissions when used in connection with red glass ranging from less than one per cent to several per cent.

If a red glass is used in the eyepiece, by total transmission for a particular temperature is meant the ratio of the brightness of the source observed through both the red glass and the black glass, to the brightness of the same source observed through the red glass alone. Without a red glass, using the entire visible spectrum, it is generally very hard to make such measurements owing to the color differences introduced by even the best absorbing glasses; with a good red glass in the eyepiece, such transmission measurements can be made easily.

The total transmission of the absorbing glass, when used with a red glass, can be calculated for any black-body distribution by the following formula, taken from Preston's Theory of Light:

$$T_B = \frac{\int J_\lambda V_\lambda t'_R t'_B d\lambda}{\int J_\lambda V_\lambda t'_B d\lambda} \qquad (7)$$

where $J_\lambda d\lambda$ = black-body energy for interval λ to $\lambda + d\lambda$, V_λ = visibility, t'_R and t'_B = spectral transmission of red and absorbing glasses,

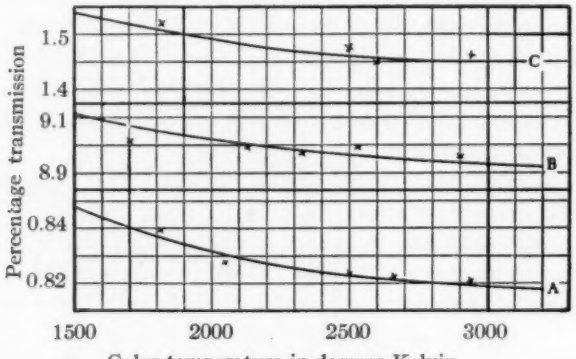

FIG. 9—Total transmission of absorbing glasses, as a function of temperature when used with red glass 4512, 5.8 mm. thick.

Curve A: two pieces Jena absorbing glass.
" B: one piece " " "
" C: Noviweld glass from Corning Glass Works.
Curves drawn through points calculated from equation

$$T_B = \frac{\int_0^\infty J_\lambda V_\lambda T_R T'_B d\lambda}{\int_0^\infty J_\lambda V_\lambda T_R d\lambda}$$

Crosses represent values of transmission obtained with optical pyrometer.

respectively. It is very evident that if the spectral transmission of the absorbing glass is different for different wave-lengths, the total transmission will be a function of the temperature of the source under investigation.

In Fig. 9 is shown, as a function of the temperature of the source, the total transmission for red light of the absorbing glasses having the spectral transmission given by curves B and C, in Fig. 8. The measured points were determined by the author and the calculated values were obtained by means of equation 7 using an average visibility curve for this spectral region. Transmission values were also calculated, using the writer's

visibility curve. Values thus obtained, using the two different visibility curves, differ from each other by only a small fraction of a per cent.

When the brightness is measured by using an absorbing glass, the temperature T_2 must be calculated, using the same formula, from the transmission of the absorbing glass, and T_1, the temperature corresponding to the pyrometer current when no absorbing glass is used. As the transmission of the absorbing glass is equal to that of the sector and the two temperatures are the same in both cases, the other unknown, that is the effective wave-length, must be the same. That is, since the transmission of the absorbing glass given by equation 7 is the same as that obtained experimentally by comparing its transmission with that of a sector, the same effective wave-length of the red glass is to be used with both the absorbing glass and a sector having the same transmission. Thus, to calculate the extrapolated brightness temperature of a source whose brightness temperature is measured, using an absorbing glass it is necessary to know the transmission of the glass as a function of the temperature of the source studied, and also the ordinary effective wave-length for the red glass used. In calculating the extrapolated temperature using an absorbing screen, it is necessary to know this temperature approximately in order to find the effective wave-length for the interval. The calculation is, therefore, one of successive approximation. When a so-called neutral tint glass is used, additional care is required because both the effective wave-length and the transmission depend on the temperature reached.

Attempts have been made to obtain an absorbing screen that is strictly neutral tint or even one that has such a transmission as to correct for the change in effective wave-length of the red glass used. Such a glass would probably be very nice but it is not necessary. What is wanted is a glass that will permit comparisons of brightness to be made by different observers with the same result. If a good red glass is used, suitable absorbing glasses can easily be found. The same thing might be said about the red glasses. Many attempts have been made to obtain absolutely monochromatic screens for optical pyrometry. This is suitable for some purposes but is not necessary, in general, and such screens have the disadvantage of not transmitting enough light to permit brightness comparisons at low temperatures. A good red glass can easily be obtained that transmits enough light to permit brightness comparison at low temperatures and at the same time is sufficiently monochromatic to enable different observers to obtain the same results, even under the unfavorable conditions existing when the comparison source and the source studied are quite different in temperature. In addition to this, if the effective wave-length of the red glass is known, all results can be readily reduced to the condition for a common wave-length.

Effect of Change in Temperature of Absorbing Glass on Its Transmission

As the spectral transmission of the red glass showed such a marked change with a change in its temperature, it was thought worth while to investigate the transmission of the absorbing glass as a function of temperature. Accordingly a heater was built and so mounted that different absorbing glasses could be heated in position to a temperature of about 200°C. Their transmissions were then measured as recorded in Table VII. These transmissions correspond to a color temperature of the source

TABLE VII

TRANSMISSION OF ABSORBING GLASSES AT DIFFERENT TEMPERATURES

Temperature °C	Noviweld absorbing glass (%)	Jena absorbing glass (%)
20	1.70	8.96
102	1.55	8.90
200	1.39	8.87

of 2380°K. The Jena glass has the spectral transmission shown by curve B, Fig. 8. The Noviweld is a piece of shade 5, which was obtained somewhat later than that used in the preceding work. These two pieces of Noviweld probably have somewhat the same spectral transmission. The Jena absorbing glass shows but a very small change in transmission due to a change in its temperature. If the spectral transmission of this glass behaves in the same manner as that of the red glass discussed above, this is what would be expected from the shape of the spectral transmission curve.

The change in transmission of the Noviweld absorbing glass is such as to indicate that the spectral transmission curve has shifted in the same direction as that shown in Fig. 5 for the red glass. No attempt has been made to investigate the effect of this temperature shift on the transmission of the glass as a function of the temperature of the source studied. The changes in transmission of the Jena glass are so small as to be negligible for any temperature change met with in practice. The changes in the Noviweld, however, are enough to cause a small error due to the temperature changes met with in practice. For a glass of this kind calibrated at a temperature of 20°C and used at a temperature of 30°C in extrapolating from 1800 to 2400°K and 3000°K, the errors would be, respectively, +7.5°K and +11.5°K.

General Notes If an optical pyrometer, as shown in Fig. 2, is constructed so as to transmit sufficient light to enable temperatures to be measured as low as 1000°K, this pyrometer will transmit too much light for comfort at high temperatures. The diaphragm before the eyepiece telescope at E can be constructed as shown so as to have several openings of various sizes. For a low temperature, the larger opening is to be used, thus transmitting more light, while for a higher temperature, a

smaller opening should be used. In this manner the same instrument can be used over a wide range without discomfort.

If too large an opening is used before the telescope eyepiece, the pyrometer filament will not disappear against the image of the background but there will be dark streaks along the edges of the pyrometer filament. If these dark streaks are too prominent, it is impossible to make consistent settings. The resolving power of whatever eyepiece is used should be so adjusted that the pyrometer filament disappears as a whole, that is, such that one does not see either dark or bright streaks along the edge of the pyrometer filament. To see what error would result due to such dark streaks, the diaphragms and the pyrometer filament were so chosen as to give marked dark streaks along each edge of the pyrometer filament. A 4-mil. (0.1 mm.) pyrometer filament was used. The arrangement of the different parts was as shown in Fig. 2, except that the opening in the diaphragm before the eyepiece telescope was 2 cm. in diameter. The results, in terms of the current through the pyrometer filament for a brightness match with a 15-mil. (0.38 mm.) tungsten lamp at a temperature of 1735°K, are given in Table VIII. As everything was kept constant

TABLE VIII

RESULTS OBTAINED BY EXPERIENCED OBSERVERS USING PYROMETER WITH DARK STREAKS ALONG EDGES OF PYROMETER FILAMENT

Day	Current in amperes through pyrometer filament		
	A.G.W.	K.H.M.	W.E.F.
1	0.9162	0.9124	0.9152
2	0.9187	0.9120	0.9179
3		0.9125	0.9169
Average	0.9174	0.9123	0.9168

during the three days these readings were made these variations are errors due to a change in the criterion for a brightness match. For the value of the current given in Table VIII, a change of about 0.0009 ampere corresponds to 1° in the temperature.

It is thus seen that for bad conditions, as to disappearance, the error for experienced observers though small is much larger than occurs when the conditions are good. The results given in Table V show that when the conditions are good these three observers get practically the same reading. In this case, however, the differences are quite large for this kind of work. If for any reason it is necessary to use a large resolving power eyepiece, good disappearance can be obtained by increasing the size of the cone of rays that reach the pyrometer filament from the objective lens. If this is pushed too far, an objective lens with a very large aperture is required. If the light is too intense for comfort, it can be cut down by using one or more additional red glasses before the eyepiece. If two red glasses are used in the eyepiece, the addition of a third red glass will reduce the ap-

parent intensity of the image by about 50%. If more light is desired for sources at lower temperatures, it is often quite a help to remove one of the two red glasses that are being used. If two red glasses are being used and one of them is removed, the brightness of the image observed will appear about twice what it did with two red glasses. If no sector or absorbing glass is used with the pyrometer there will be very little effect on temperature measurements if the number of red glasses in the eyepiece is changed. If a sector or absorbing glass is used corrections will have to be made for the change in effective wave-length for the number of red glasses used.

Polarization To test out the effect of polarization with this type of pyrometer, a large nicol was mounted directly in front of the pyrometer lamp and readings were made with the position of the nicol varied with respect to the pyrometer filament. It was found that, with a red glass before the eyepiece of the pyrometer, the apparent brightness of the background (a black body) was about 1% more when the nicol was so set that the transmitted light was polarized in a plane at right angles to the pyrometer filament than with the nicol turned through 90°. Since the source is known to be free from polarization, this shows that the effect of polarization is almost negligible even when all the light is polarized. From the work on diffraction around the pyrometer filament already referred to, a small difference would be expected even with this instrument.

Position of Rotating Sector If the rotating sector is used to cut down the apparent intensity of the background, care must be taken as to the location of the sector. There is a marked difference in the results of temperature measurements, depending on whether the sector is located near the objective lens or as near as possible to the pyrometer lamp. There is also a difference depending on the relative position of the openings in the sector and the source, providing the source is a lamp filament. If a sector of small transmission is mounted near the lens and so placed that the openings of the sector are parallel to the axis of the background filament when the sector is passing across the center of the lens, the definition will be very bad, while if the openings of the sector are turned through 90°, so that they are perpendicular to the axis of the filament, the definition will be quite good, but not as good as if the sector is located near the pyrometer lamp. When the rotating sector is located near the pyrometer lamp, the definition is good and practically independent of the position of the opening of the sector. If a very large source is used no such effect is noted. Using a pyrometer calibrated against such a large background, and thus independent of the position of the sector, to measure the brightness temperature of a small tungsten filament, large variations in temperature were found when different sectors were used near the objective lens. No such differences were found when the sector was located near the pyrometer filament.

TABLE IX

ERRORS IN TEMPERATURE MEASUREMENTS DUE TO IMPROPER LOCATION OF SECTOR

	Near lens		Near pyrometer lamp	
Position of 2° sector	Opening of sector parallel to background filament	Opening of sector perpendicular to background filament	Opening of sector perpendicular to background filament	Opening of sector perpendicular to background filament
Current, in amperes through pyrometer filament for brightness match	0.3332	0.3354	0.3357	0.3357
Apparent relative brightness	0.9390	0.9950	1.0000	1.0000
Temperature of background for these readings in °K	2263	2275	2277	2277

In Table IX are given results of a test showing the effect of the position of the sector. A 15-mil. (0.381 mm.) tungsten lamp operated at a brightness temperature of about 2275°K was used as a background and readings were made on the current through a $2^1/_2$-mil. tungsten pyrometer filament, for an apparent brightness match with a sector having two 1° openings. From the table it can be seen that the position of a sector of this size can cause an error of about 14°K for this condition if care is not taken as to its location. When a sector is used, it should be rotated so fast that no flicker is noticeable. Not only is an error apt to be made if the sector is not rotating fast enough, but the flicker is bothersome in making accurate brightness comparisons.

Errors Due to Various Causes

In Table X is given the variation in extrapolated temperature due to a variation in initial temperature, in effective wave-length, in transmission of absorbing glass or transmission of sector, and in current through the pyrometer filament. First, is given the change in the temperature due to one per-

TABLE X

CHANGES IN TEMPERATURE OF 2400°, AND 3000°K EXTRAPOLATED FROM 1800°K AS INITIAL TEMPERATURE, USING WIEN'S EQUATION, DUE TO VARIOUS CHANGES

	Percentage change			Actual change (°K)		
Variation leading to error	1800	2400	3000	1800	2400	3000
Change of 1% in initial temperature	1.0	1.30	1.70	18.0	32.0	50.0
Change of 3°K in initial temperature				3.0	5.0	8.0
Using a wave-length, 1% in error		0.30	0.70		8.0	20.0
0.001μ error in wave-length		0.50	0.10		1.2	3.0
If in extrapolating the λ_e of red glass between 1300° and 1800°K is used (see Fig. 4)		0.10	0.30		2.4	7.5
Calibrating pyrometer filament against tungsten lamp as background that was standardized with a red glass different from one used in pyrometer being calibrated. Suppose λ_e to change from 0.665μ to 0.650μ				3.5		
Error of 1% in value used for transmission of sector or absorbing glass		0.26	0.32		6.2	9.6
Variation of 1% in current through $2^1/_2$ mil. pyrometer filament.	0.5	0.70	0.80	9.0	16.0	25.0

centage variation of each and then some other possible variation. An inspection of this table will show that in extrapolated temperatures quite an error is allowed in the effective wave-length or the transmission of the sector or of the absorbing glass without any great error in the final results. Any error, however, in calibrating at the initial temperature will cause a much larger error in the final result.

If a tungsten lamp is used as a background to standardize pyrometer lamps, for the highest accuracy, either the same kind of red glass must be used in calibrating the standard as is used with the pyrometer being calibrated, or correction must be made for the difference. The example given in the table corresponds to the difference between two glasses having the spectral transmissions shown by curves A and C, Fig. 3.

If with the use of sectors or otherwise the pyrometer is calibrated to give relative brightness instead of temperature, the pyrometer is quite valuable for measuring the relative brightness of different sources. The pyrometer, thus calibrated, can also be used to measure the transmission of different glasses as, for instance, the transmission of the lamp bulb when an attempt is made to get the actual temperature of a filament. These transmissions and relative brightnesses will correspond to the monochromatic glass used in the eyepiece.

Temperature of Nonblack Bodies

The value of the temperature for any source obtained with an optical pyrometer must be calculated from the observed brightness for a particular wave-length interval. The only body for which this relation is given from a theory known is the black body, and for this it is given by Wien's equation. From the definition of a black body and Kirchhoff's law, all other bodies that owe their brightness to thermal causes alone are less bright when at a particular temperature than a black body at the same temperature. Thus, if the temperature of any hot nonblack body is calculated from a measurement of its brightness as though it were a black body, values that are lower than the true temperature will be obtained. The temperature obtained, however, is the temperature that a black body must have in order to have the same brightness for the particular wave-length interval as the body being investigated. The difference between the true temperature and the temperature thus obtained varies from a few degrees, for such a substance as untreated carbon, to more than 200°C for such a metal as polished platinum at its melting point. These temperatures are called black body brightness temperatures or shortened to brightness temperatures.

Objections have often been made to the use of red glass screens on the ground that as the range of wave-lengths transmitted was so large, there was no method of knowing to what wave-length the resulting temperature

was to be assigned. If the effective wave-length of the red glass used is known for different temperature ranges, the results can be treated just as definitely as if an absolutely monochromatic screen were used; in addition, the red glass has the added advantage of transmitting enough light to enable very accurate brightness comparisons to be made.

The above discussion represents in a general way the results of work in this general field that has been carried on in the Research Laboratories at Nela Park for the past several years. When we first entered upon this work of determining high temperatures, many of the relations and constants had not been worked out. In the past ten or fifteen years there has been considerable work done in this field. There is, however, more work that should be done. For several years we have been using the pyrometer built and calibrated as above described. We hope that in the future someone will find time to go farther with some of the things suggested in this paper.

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Abrasives

Design reduces manual effort. ANON. *Abrasive Ind.*, **10** [10], 26–28 (1929).—Four grinding machines with hydraulic features and a new crankshaft lapping machine are included in the Norton exhibit at the National Machine Tool exposition. The machines with hydraulic mechanism include a new double-head crank-pin grinding machine, a type *A* cylindrical grinding machine with hydraulic rapid wheel slide motion, a type *BA* cylindrical grinding machine with hydraulic power table traverse and the openside surface grinding machine recently brought out with hydraulic table traverse. E.P.R.

Electric grinder. ANON. *Abrasive Ind.*, **10** [10], 35–36 (1929).—A feature of this machine is its jointless, wireless rotor. It weighs $16^1/_2$ lbs. and carries a wheel 6 inches in diameter with a $1^1/_2$-in. face. The overall length of the tools is $16^3/_4$ in. and the free and loaded speeds are 3600 and 3300 revolutions per min., respectively. E.P.R.

Swing-frame grinders. ANON. *Abrasive Ind.*, **10** [10], 57 (1929).—The Norton Co. has issued two interesting circulars describing its 24- and 16-in. swing-frame machines for high-speed snagging. Full specifications are given and reproductions from photographs showing the actual construction of the machines are included. E.P.R.

Tap grinder. ANON. *Abrasive Ind.*, **10** [10], 56 (1929).—The J. G. Blount Co. (Everett, Mass.), has developed a machine for grinding small taps; wheels of small diameter and width are used, while on larger taps, grinding wheels up to 6 in. in diameter and $^1/_2$ to $^3/_4$ in. wide are employed. E.P.R.

Grinder has sectional wheel. ANON. *Abrasive Ind.*, **10** [10], 31–32 (1929).—These grinders are manufactured in several sizes to accommodate a wide range of different classes of work. Type No. 94 carries a 42-in. segmental grinding wheel and has a capacity in length of 86 in. Many improvements have been incorporated into these face grinders to expedite production, accuracy, and convenience of operation. E.P.R.

Disk grinders handle heavy work. ANON. *Abrasive Ind.*, **10** [10], 33–34 (1929).—This 40-in. super disk grinder is designed to handle work much larger or heavier than is possible on the average disk grinder, and at rapid rates of production. It operates semi-automatically, eliminating most of the manual labor ordinarily performed by an operator. E.P.R.

Cylindrical grinder is automatic. ANON. *Abrasive Ind.*, **10** [10], 32–33 (1929).—The Arter automatic cylindrical grinder is used to grind automatically by the straight-in feed method, straight or tapered diameters such as are presented on roller bearings, valve push rods, valve stem guides, shafts, and similar work which can be held on centering devices. E.P.R.

Grinders embody hydraulic feeds. ANON. *Abrasive Ind.*, **10** [10], 28–30 (1929).—The Landis Tool Co. has applied the principles of modern semi-automatic design to the grinding of raceways in its 5-in. semi-automatic hydraulic ball race grinder. Either internal or external raceways or face raceways for end-thrust bearings may be ground on a high production basis. Other forms of radial grinding also come within its range. Semi-automatic operation without complicated mechanisms is made possible through the use of hydraulic power for three machine movements; oscillating the work head, feeding the wheel head, and traversing the wheel-head slide. E.P.R.

Oscillating grinder exhibit. ANON. *Abrasive Ind.*, **10** [10], 30 (1929).—The Van Norman Machine Tool Co. has exhibited an oscillating grinder which has been completely motorized and has many features which are a radical departure from the previous standards. The utilization of these features is double the production which can be secured from the older type machines manufactured by the company. E.P.R.

Internal grinder. ANON. *Abrasive Ind.*, **10** [10], 34 (1929).—The machine described is of the open-end type with the grinding wheel entering the work from the rear, thereby providing safety for the operator. It has an hydraulic drive and the valve mechanism and controls are entirely hydraulic in action. A product of the Greenfield Tap & Die Corp. (Greenfield, Mass.). E.P.R.

Design surface grinder for die grinding. ANON. *Abrasive Ind.*, **10** [10], 34–35 (1929).—The use of punched and pressed shapes requiring a multiplicity of punch press dies has caused an advance in industrial economics. A large surface grinding machine has been designed for these. It is massive, powerful, and provided with unusual traverse capacity. E.P.R.

Grinder operates at high speed. ANON. *Abrasive Ind.*, **10** [10], 36–37 (1929).—The new high-speed stand grinding machine is described. The grinder carries 20-in. diameter high-speed wheels with 10-in. center holes at a surface speed of 9400 ft. per minute. It is driven by either a 5 or $7^1/_2$ H.P. totally inclosed alternating- or direct-current motor. This machine was developed primarily for rough grinding aluminum, brass, and bronze castings. Grinding cost on this class of work is materially lowered when done with this high-speed machine and wheels. E.P.R.

Wedges reclaimed by grinding. ANON. *Abrasive Ind.*, **10** [10], 38 (1929).—The journal wedge reclaimer is a simple device. It grinds accurately and rapidly the correct radii on both new and worn journal wedges. E.P.R.

Wheel selection in snagging operations. B. WYNN. *Abrasive Ind.*, **10** [10], 49 (1929).—A snagging operation consists of the rapid removal of large quantities of metal from rough castings, large or small, as they come from the molds. The selection of wheels for this work is governed by the kind of material to be ground, finish desired, amount of metal to be removed, type and condition of the grinding machine, peripheral speed of wheel, and skill of workman. Therefore, the only positive means of determining the wheel best suited for the work is to test it under actual operating conditions. Castings made of high tensile strength materials, starting with the hardest and toughest alloy steels, hard unannealed malleables, and the tougher grades of bronze require an abrasive composed of electrically fused alumina known as aluminum oxide. The reason for the aluminous abrasive being used is that it gives longer life and cuts faster. On castings of thin section there is a tendency to check and crack when silicon carbide is used. For grinding steel castings a bakelite bond wheel has been recommended. This bond makes the wheel exceptionally strong and will stand up under heavy strain. Steel is harder to grind than cast iron. The bakelite bonded wheel increases production and reduces the cost of removing fins and irregularities. Materials of low tensile strength, such as soft brasses and bronzes, and cast and chilled iron, are more efficiently ground with silicon carbide. Aluminum castings can be snagged by aluminum oxide or silicon carbide. Where castings cannot be handled by two men or by the help of a small hoist they are ground with swing-frame grinders. Harder grade wheels are used because of the greater vibration of machines; coarser grains are used because large rough castings with much stock to be removed are ground. If the grinding wheel is run at too low a speed it is likely to wear away too fast without cutting its maximum and if the wheel is run too fast, the cutting action may be retarded. To get uniform results, snagging wheels made by the vitrified process should be operated at between 5000 and 6000 surface ft. per min. and rubber bonded or bakelite bonded wheels operated at 8000 to 9000 surface ft. per min. E.P.R.

Wheel truing. ANON. *Abrasive Ind.*, **10** [10], 40 (1929).—The nib in which a wheel-truing diamond is mounted can be turned in its holder to present a new cutting surface after the stone is worn flat. In grinding accurate work, it is necessary to keep the wheel true, particularly when taking finishing cuts. The diamond should be fed

past the wheel at a uniform rate of speed which should be slow enough to give the diamond a chance to cut away the worn abrasive grains. E.P.R.

Wheel selection. ANON. *Abrasive Ind.*, **10** [10], 44 (1929).—As a rule, a coarse wheel is used where coarse finish is desired and vice versa. There are limitations to this rule, especially when considering precision work on a cylindrical grinder. If a 20-grit wheel is dressed with a star-wheel dresser it will impart a coarse finish. Such a wheel will cut freely. If the 20-grit wheel is trued carefully with a diamond tool using a slow speed and plenty of water, it will impart a finish as good as would be desired from a 40-grit wheel. The diamond cuts away the abrasive particles leaving a smooth surface and the star-wheel dresser tears out the dull grains and opens a free cutting surface. E.P.R.

Grinding wheel dresser. ANON. *Brass World*, **25** [9], 218 (1929).—The Ross Manufacturing Co. (Cleveland,Ohio), claims that the dressing tool has greatly increased life, higher accuracy in operation, marked reductions in wheel truing costs, and other desirable features. E.P.R.

Mounting a grinding wheel on its collet. R. E. W. HARRISON. *Abrasive Ind.*, **10** [10], 48–49 (1929).—The collet should be laid on a bench for wheel mounting and the wheel held between the collet and flange with either rubber or blotting paper washers interposed. Satisfactory results can be obtained with the safety-type washer, a thin sheet metal base with rubber facing. To insure the wheel not moving on the collet, it must be a good fit with not more than 0.005-in. clearance on the diameter. The assembled wheel and collet is balanced. E.P.R.

Nonprecision parts ground rapidly by centerless method. J. H. GROOM. *Abrasive Ind.*, **10** [10], 43–44 (1929).—The use of a precision grinding machine on nonprecision production work may seem out of place, but centerless grinding machines are in use daily for performing a number of unusual operations that heretofore were done manually. A number of unique operations performed on centerless grinders with the object of expediting production rather than imparting a high degree of accuracy are illustrated and described. The article is of more than usual interest as it shows graphically the extent to which the grinding field is being broadened. E.P.R.

Work speed. ANON. *Abrasive Ind.*, **10** [10], 41 (1929).—In ordinary cylindrical grinding practice the work revolves toward the operator, its direction of rotation being the same as that of the wheel. If the work is revolved in the opposite direction, a negative work speed results. This method for many years was not considered practicable by abrasive engineers, although it has been used in specific cases on ordinary cylindrical grinding machines with excellent results. The result of a negative work speed, of course, is to reduce materially the ratio between the rotation of the work and that of the wheel. E.P.R.

Diamond tools. ANON. *Abrasive Ind.*, **10** [10], 57 (1929).—The Standard Diamond Tool Corp. (New York), has issued a booklet called Useful Hints on the Care and Use of Diamonds in Grinding Wheel Dressing. The condensed experience of 25 years of practice and experimentation in hundreds of plants where grinding machines are used is given. It has purposely been made simple and every point is valuable. Illustrations of the various types of diamond tools used in grinding machines are given and the data pertaining to the use of diamonds are unusually complete. E.P.R.

Exhibit abrasive materials at exposition. ANON. *Abrasive Ind.*, **10** [10], 40 (1929).—Abrasives and abrasive equipment played an important part in the exposition of the National Metal Congress held in Cleveland, Sept. 9–13, 1929. E.P.R.

Heavy grinders assure high speed. ANON. *Abrasive Ind.*, **10** [10], 38–39 (1929).—Great improvements have been made in heavy duty high-speed equipment for rough

grinding during the past few years. Typical examples of such units are illustrated. E.P.R.

Increase capacity by use of Bryant grinding machines. ANON. *Abrasive Ind.*, **10** [10], 36 (1929).—The principle on which Bryant internal grinding machines operate consists of a rotating work head with the wheel head traversed over an overhead arm. As this arm can be finished by grinding to assure its being absolutely straight and round, it is obvious that these machines will generate round and straight holes. E.P.R.

New buffer provides range of speeds. ANON. *Abrasive Ind.*, **10** [10], 37 (1929).—The U. S. multi-speed buffer and polisher is described. Transmitting different speeds is done by a Gibbs V-disk transmission. A cone or series of different-sized disks revolve on the motor spindle. Any one of these, depending on the speed desired, can be quickly inserted into a stationary, metal V-disk or sheave mounted on the wheel spindle. E.P.R.

Polishing aluminum. ANON. *Brass World*, **25** [9], 215 (1929); *Grits & Grinds.*—Practically all aluminum articles are polished and each type of article made of this soft, ductile metal presents a different polishing problem. These are discussed and specific methods and materials described. E.P.R.

PATENTS

Grinding machine. FRANK S. HARRELL. U. S. 1,729,288, Sept. 24, 1929. A grinding machine comprising a support, a motor carried thereby, a hollow shaft rotated by the motor, a solid shaft slidable in the hollow shaft and turnable therewith, a tool carried by the solid shaft, means for advancing the solid shaft while it is rotating, the means including a manually actuated screw and a ball bearing disposed between the end of the screw and the solid shaft, and means for adjusting the longitudinal axis of the solid shaft laterally with respect to the support.

Segmental abrasive wheel. THURE LARSSON AND HUGO W. H. BETH. U. S. 1,729,585, Sept. 24, 1929. A wood-pulp grinding wheel comprising a rotatable support, a plurality of rows of abrasive segments arranged thereon to form a cylindrical grinding surface, a freely movable friction member located between and in engagement with the inner faces of adjacent segments, and clamping flanges associated with the rotatable support, and adjustably engaging the exposed faces of the end segments of the wheel to press the segments and friction member into frictional contact and to hold them in assembled relation.

Centerless grinding machine. HAROLD W. HOLMES. U. S. 1,729,780, Oct. 1, 1929. A grinding machine comprising a rapidly rotated grinding wheel and a slowly rotated work-regulating wheel, means for holding work of round section between the wheels, the means including a relatively fixed member and a relatively movable member, the latter being movable toward and away from the first-mentioned member, and a mechanism constructed and arranged to move the second-mentioned members to positions parallel to the work axis into contact with the work to hold the work between itself and the other member during grinding and away from the ground work to permit discharge thereof.

Grinding machine. HENRY H. YERK AND WILLIAM J. BAUMBERGER. U. S. 1,730,551, Oct. 8, 1929. In a portable grinding machine for grinding locomotive crank pins, etc., in combination, a frame, means associated with the frame to adjust the frame vertically, a base adjustable transversely of the frame, a carriage movable longitudinally of the base, a rotatable annular headstock mounted on the carriage, a rotatable grinding wheel spindle journaled in the headstock, a motor carried by the carriage, driving means driven by the motor whereby to simultaneously rotate the grinding wheel spindle, rotate the headstock, and reciprocate the carriage longitudinally of the base.

Grinding machine. WILLIAM J. BAUMBERGER. U. S. 1,730,838, Oct. 8, 1929. In a grinding machine of the character described, a pair of oppositely disposed grinding wheel spindles, mechanism for rotating the spindles about their axes and orbitally about axes eccentric to the spindles, a work-feeding table reciprocable intermediate the spindles, mechanism for reciprocating the table, and common variable speed mechanism for actuating the table reciprocating mechanism and the mechanism for causing orbital movement of the spindles at constant speed ratio.

Grinding machine. HERBERT E. KEMPTON AND KEITH F. GALLIMORE. U. S. 1,731,719, Oct. 15, 1929. A grinding machine having, in combination, a rotary work holder, a grinding element, means for effecting relative movement between the two to bring the grinding element into and out of operative grinding position with reference to the work, gage means mounted to gage the work automatically during the grinding operation, means controlled by the gage means automatically operable to cause the first-mentioned means to remove the grinding element from the work before the completion of the grinding operation, and means operable upon such separation to cause the first-mentioned means to return the element to the work to complete the grinding operation.

Abrasive compositions containing phenol condensation products. CARBORUNDUM CO., LTD. Brit. 316,189, Sept. 18, 1929. A composition for the manufacture of abrasive articles, comprising abrasive granules and powdered synthetic resin, is mixed at a temperature below about 70°F to avoid gumming of the resin which would result in a non-uniform mixture. The mixture is cold pressed and baked. The abrasive material may consist of silica, garnet, silicon carbide, fused alumina, magnesia or aluminium silicate, or glass, and the resin may be a phenol condensation product. The abrasive granules may be first wetted with furfurol and then mixed with the powdered resin some of which becomes attached to the granules so that the mixture is workable at temperatures below that at which the resin becomes gummy. The mixing may be effected in a room automatically kept below the critical temperature by a thermostat which actuates a refrigerating system if this temperature is exceeded, and as excessive moisture present in the air will condense on the pipes of the refrigerator, the humidity of the atmosphere will also be controlled. The mixing temperature may be as low as 48°F. The temperature of the mixture may also be controlled by water jackets. The mixture may comprise 900 g. of abrasive, 100 g. of resin, and 10 cc. of furfurol.

Shaping grinding wheels for gear cutting. G. E. VOIGNIER. Brit. 316,304, Sept. 18, 1929. A grinding wheel for rectifying gear teeth of involute shape is shaped by a diamond, which is caused to move across the profile of the grinding wheel in the desired curve by a linkage consisting of a member which may be in several adjustable parts, and is adapted to be secured to a framework.

Abrasive paper. CARBORUNDUM CO., LTD. Brit. 316,308, Sept. 18, 1929. To prevent the abrasive surface of abrasive paper from becoming concave due to the contraction of the adhesive upon drying, the back of the paper also is coated with adhesive or other substance, which, on contraction, causes the paper to become flat, or with the abrasive surface convex, the flattening also may be achieved by the use of paper having plies of different contractile characteristics or by the use of paper which will counteract the contraction of the adhesive.

Abrasive disks. CARBORUNDUM CO., LTD. Brit. 316,676, Sept. 25, 1929. An abrasive disk having a cloth, etc., backing cemented to one face, has that face formed with abrasive material of finer grain than that of the body of the disk, in order to prevent the entry of the cement into the pores in the body of the disk, and thereby modifying the abrasive properties of the disk. The disk is formed in a mold, a thin layer of fine abrasive of 40 to 60 grit mixed with a binder being placed in the mold, the main body of the

disk of coarser grain then being placed on the layer and the disk then being pressed and baked. The fine-grain portion may be confined to a portion only of the disk by placing a paper, etc., disk on the mold and removing that disk after introduction of the fine grain abrasive, etc.

Art

New designs in crystal and whiteware. ANON. *Crockery and Glass Jour.*, **107** [9], 32–33 (1929).—The Dawn pattern was introduced by Edw. D. Dickinson, Inc., on ivory body with a new vellum glaze. The motif, which is in enamel, employs a bird and branch design combined with flower clusters done in bluish gray and apple-green. New designs in crystal, imported from Sweden, are to be found at the Bassett showrooms. Hugh C. Edmiston is displaying china flowers including carnations, poppies, daffodils, roses, etc., in natural colors. The new dinnerware pattern of Graham & Zengers consists of rose designs done in a delicate green. The entire line is on ivory body and shows a rose and leaf cluster in the center with five equally spaced sprays on the outside. Justin Tharaud, Inc., is showing a new Spanish style known as the Cortez pattern. It is done in enamels in combination with a rich ivory band background. The treatment consists of three equally spaced flower and leaf sprays done in colors of green, brilliant red, yellow, and blue. The Aladdin shape is the newest design of the C. C. Thompson Potteries Co. It is done in ivory and employs small roses and forget-me-nots in combination with medallions. E.P.R.

New designs and glazes. ANON. *Ceram. Ind.*, **13** [4], 383 (1929).—With formal approval of designs and glazes, the Sebring (Ohio) Pottery company is ready to begin shipment of gift ware designed by Vally Weiselthier of New York, and exhibited for the first time at the Eighth Annual Gift Show at Chicago in August. A. E. Baggs of the Ceramic Art Department, Ohio State University, assisted with this work. The new glaze which is bright red, orange, yellow, green, and blue was fired at 1850°F. F.P.H.

Decorative importance of porcelain vases. EDWARD WENHAM. *Arts & Dec.*, **31** [5], 60–61(1929).—Description and illustrations of many porcelain vases (identified as porcelain because translucent) some delicately painted, some modeled, and some with applied flower forms. Probably the three outstanding factories that remain of the early English are Spode, Mintons (Wedgwood), and Royal Worcester, these having survived because they have remained true to the traditions of the founders. To Louis Solon we owe the magnificent decoration known as pâte-sur-pâte (paste on paste). It is a combination of painting and sculpturing, layer after layer of liquid clay being painted on and later sculptured E.B.H.

Color measurements with the Moll's "extinctiometer." M. J. VAN TUSSENBROEK. *Chem. Weekblad*, **26**, 374–81 (1929).—The use of glass filters overcomes the difficulty that separate readings cannot be taken for each wave-length. The advantages of the method are rapidity, sensibility, and independence of the imperfections or fatigue of one's eyes. (*C.A.*)

Protecting original designs. WALDON FAWCETT. *Enamelist*, **6** [9], 30–34 (1929).—Since art and color have invaded the enamel lines design protection becomes a serious problem. There are two agencies open to the manufacturer for design protection: (1) the design patent and (2) the recourse to the common law of unfair competition. The disadvantage of the latter is that redress may only be had after the design has been borrowed or stolen. G.H.McI.

Indoor kennel. ANON. *Int. Studio*, **94** [389], 56 (1929).—Many illustrations of earthenware and porcelain dogs produced by all the great potteries of England are to be seen in the Old Mill at Buckinghamshire, England. The difficulty of modelling curly wool is overcome in many ways, one means being the use of small granules glazed fast in the manner of sandpaper. E.B.H.

Arthur Covey's decorations. A. C. HIGGINS. *Amer. Mag. Art*, **20**, 536–38 (1929).—In the Administration Building of the Norton Co. at Worcester, Mass., are ten mural paintings by C., illustrating processes as carried out in the Norton plant. Two (reproduced) are the making of grinding wheels and loading the kiln. H.H.S.

Kansas City's Art Museum plan. HOWARD E. HUSELTON. *Amer. Mag. Art*, **20**, 498–502 (1929). H.H.S.

Free museums in Italy. ANON. *The Times*, Aug. 9, 1929.—The Italian Government has abolished all entrance fees into State galleries and museums. H.H.S.

Tile-making during the 13th and 14th Centuries. ARTHUR PONSONBY. *Brit. Clayworker*, **38** [449], 200–202 (1929).—P. discusses the beautiful tile pavements with which the monastic churches of The Middle Ages were embellished. This type of tile-making was exclusively a monastic industry and flourished in the 13th and 14th Centuries. R.A.H.

Andrea della Robbia. RALPH FANNING. *Design*, **31** [4], 65–69 (1929).—Active, experimental, and original tendencies of all Florentine Renaissance are shown in the work of Andrea della Robbia. The success of enameled terra cotta had given to the della Robbias an unequalled prestige in the popular taste of the time. The work of Andrea may be divided into three parts, the first showing the influence of (1) his uncle, Luca, (2) his own free expression, and (3) when his work blended with his son, Giovanni, who supplanted the influence of Luca. His art is a bit theatrical, sometimes overwrought with useless details and too many figures. The most popular della Robbia works ever produced are the Innocenti or Bambinos, the sentimental appeal of which perhaps has detracted from their high merit in pure design. In the terra cotta tympanum depicting the meeting of St. Dominic and St. Francis the faces and hands are for the first time left unenameled, better to accent the rigid character of the saints. His later more complicated works proclaim the advent of the technique of later art. E.B.H.

Chinese porcelain. ANON. *The Times*, Aug. 9, 1929.—The British and other Museums have received important accessions under the will of Henry Blackwall Harris, a prominent member of the Oriental Ceramic Society. H.H.S.

BOOKS

Chippewa Customs. FRANCES DENSMORE. *Bur. Amer. Ethnology*, Smithsonian Inst., *Bull.*, No. 86. U. S. Govt. Printing Office, Washington, D. C., 1929. Price $1.60. Pottery making and other arts are considered in the various phases of tribal life. Reviewed in *Amer. Mag. Art*, **20**, 544 (1929). H.H.S.

How to Recognize Porcelains and Faience by Their Marks and Character. II. 19th Century. (French). E. S. AUSCHER. Librairie Garnier, Paris, 1929. Price 24 F. H.H.S.

Georgian Art (1760-1820). BERNARD RACKHAM, LOUISE GORDON-STABLES, ET AL. *Burlington Magazine*, Monograph No. III. B. T. Batsford, Ltd., London, 1929. Price 30 s. R., dealing with ceramics and glass, sketches the developments of English pottery from medieval times in order to give the reader a basic understanding of the origin of Georgian ware. G-S. includes enamels in the section on minor arts. H.H.S.

PATENTS

Design for a vase. JESS CLAIR KELLY. U. S. 79,467, Sept. 24, 1929 (reissue).

Design for a goblet, etc. ALBERT B. GUNTHEL. U. S. 79,516, Oct. 1, 1929 (reissue).

Design for a combination holder for tumbler, brushes, and collapsible tube. JOHN MCG. GILFILLAN. U. S. 79,554, Oct. 8, 1929 (reissue).

Design for a bottle. ROYDEN A. BLUNT. U. S. 79,454, Sept. 24, 1929; JACQUES

FAILLIOT. U. S. 79,460, Sept. 24, 1929; SIDNEY O. BRIGGS. U. S. 79,551, Oct. 8, 1929; FRANK K. EDWARDS. U. S. 79,585, Oct. 15, 1929 (reissues).

Design for a plate, etc. FERDINAND SCHMIDT. U. S. 79,482, Sept. 24, 1929; LOUIS BILTON. U. S. 79,547 and U. S. 79,548, Oct. 8, 1929; ALEXANDER WATERS MACKENZIE. U. S. 79,593, Oct. 15, 1929; JOHN E. PHILLIPS. U. S. 79,608, Oct. 15, 1929 (reissues).

Cement, Lime, and Plaster

Hydration of the aluminates of calcium. I. A new crystalline form of hydrated tricalcium aluminate. T. THORVALDSON AND N. S. GRACE. *Can. Jour. Research*, **1** [1], 36 (1929).—In an investigation of the resistance of Portland cement to sulphate action a new form of hydrated tricalcium aluminate, with six molecules of water, was prepared by treating pure tricalcium aluminate with steam under pressure and drying the product over quicklime. This hydrate is crystalline and isotropic. It is stable at 100°C but at 275 to 300°C it gives up three-quarters of its water, forming a stable 1.5 hydrate. Some water is retained up to 1000°C. Before the last water is expelled decomposition of the aluminate takes place with the formation of the anhydrous 5 to 3 calcium aluminate and lime. Recombination occurs at 1000 to 1100°C. W.L.

Thermal expansion of cements. C. R. PLATZMANN. *Tonind.-Ztg.*, **53** [43], 766–67 (1929).—The following values for the coefficients of expansion of various cements and building materials are given.

Material	Coefficient of expansion ($a \times 10^{-6}$) Temp. range (50–100°C)	(400–500°C)
Portland cement	1.12	1.42
Karo cement	1.01	1.41
Atlas lumnite	0.64	0.90
Ciment fondu	0.67	0.78
Granite	0.80	1.48
Sandstone	1.18	1.76
Limestone	0.91	1.57

F.P.H.

Action of aggressive solutions on cements and concretes. PROBST AND DORSCH. *Zement*, **18** [10], 11 (1929); *Rock Prod.*, **32** [20], 89 (1929).—The authors investigated the effects produced in different cements and cement mixtures by the action of aggressive chemical solutions such as a 15% sodium sulphate, 15% ammonium sulphate, saturated calcium sulphate, 15% magnesium chloride, and 15% sugar. The data obtained showed that the alumina cement is the most stable against aggression of sulphate-bearing solutions, showing only 6.67% SO_3 after four months' storage in ammonium sulphate, the order of stability being high grade Portland cement, ordinary Portland cement, blast-furnace cement, Portland "jurament," alumina cement. The cements prepared with Rhine sand, due to the greater compactness, were more stable to sulphate than the standard sand-made specimens. The tests confirmed again that cements lean in lime are more stable to sulphates. After 360 days' storage in saturated solutions of calcium sulphate, 15% magnesium chlorate, 15% sugar solution, no traces of disintegration were observed in any cement except the high-grade Portland cement which showed disintegration after 305 days in saturated calcium-sulphate solution. F.P.H.

Notes on plaster of Paris. S. M. MARATHE AND A. D. JOSHI. *Jour. Ind. Ceram. Soc.*, **1** [3], 88–92 (1929).—In the use of large quantities of plaster of Paris, much saving and improvement in the quality of the ware can be accomplished by its proper control, especially for casting. The salt crystallizes and has an internal disruptive pressure causing the plaster molds to have very short life. Experimental work is described

in which the physical properties of set plaster were studied by varying the amount of water added to it. The following conclusions are given: (1) porosity and the absorbing power of a plaster mold vary directly as the water added while pouring; (2) strength varies inversely as the water added; (3) the best proportion of water to plaster is about 300 g. of water to 1000 g. of plaster. Some of the problems suggested for investigation are as follows: (1) What is the change in cohesion of plaster particles when soaked in water or salt solution? (2) Does all the salt creep to the surface and then crystallize there or does some of it crystallize in the plaster body; what pressure is exerted by the crystallization? (3) Would a dip in the clean water (just after the cast article is taken out) remove the salt in the internal pores and thus increase the life of a plaster mold? A.A.

Gypsum. W. M. MYERS. *Mineral Ind.*, **37**, 293–95 (1928).—The growing trend toward the diversification of gypsum products and related commodities was evident during the year. The increased use of specially prepared plasters for the improvement of acoustical conditions has been of interest. Sound insulation designed to prevent the transmission of excessive noise from one location to another has also been introduced successfully. This involves the use of a specially designed resilient system employing gypsum-block walls, a light-weight, flocculent, gypsum filler, and carefully designed clips and hangers for the suspension of structural members. The introduction of a specially prepared and dimensioned gypsum board has been successful in replacing the wooden lath. New York State continues to be the largest producer of gypsum. The use of synthetic gypsum, produced as a by-product in certain chemical industries, made some progress. The use of this material has been hampered by the lack of sufficient tonnage and nonuniformity. (For previous abstract on this subject see *Ceram. Abs.*, **8** [4], 252 (1929).) E.P.R.

Porous gypsum plaster products. JOSEPH ROSSMAN. *Rock Prod.*, **32** [20], 74–77 (1929).—A survey is made of the U. S. patents relating to the compositions and methods for producing porous plaster products. F.P.H.

Formation of two different calcium-sulpho-aluminates from the gypsum in cement. P. MECKE. *Tonind.-Ztg.*, **53** [38], 681–84 (1929); *Rock Prod.*, **32** [20], 89 (1929).—Employing a Portland cement and two slag cements, M. determined the solubility of the sulphur combinations before and after the set in hot and cold water and the solubility of mixtures of gypsum and cement after the set in cold water. He compared the results of these tests, presenting synthetic representations of various sulpho-aluminates, the whole including microscopic, microchemical, and optical testing. The action of hydrate of lime and aluminate upon the sulpho-aluminate $(CaO)_3 \cdot Al_2O_3 \cdot 3CaSO_4$, produces a salt of the composition $3(CaO) \cdot Al_2O_3 \cdot 2CaSO_4$. This formation of one salt from the other may be expressed by the following formula: $2[(CaO)_3 \cdot Al_2O_3 \cdot 3CaSO_4] + (CaO)_3 \cdot Al_2O_3 = 3[(CaO)_3 \cdot Al_2O_3 \cdot 2CaOS_4]$. Both sulpho-aluminates are differentiated outside of their molecular composition, by their different crystal shapes, the optical behavior of the crystals, and by the fact that in the formation of the second salt the sulphuric acid precipitates almost entirely, even from much diluted solutions, whereas in the formation of the salt according to Michaelis about 40% of the sulphuric acid still remains in the solution after 24 hrs. When, during the set of the cement, a greater quantity of hydrate of lime or lime aluminate arises than is necessary for the formation of the Michaelis salt, $3(CaO) \cdot Al_2O_3 \cdot 3CaSO_4$, from the gypsum, the excess must act chemically upon this. It can therefore be assumed that the so-called cement bacillus consists of the more stable calcium-sulpho-aluminate. F.P.H.

Apparatus for firing gypsum. L. MARTIN. *Tonind.-Ztg.*, **53** [34], 655–56 (1929).—The Volker system for firing gypsum is described and its advantages over other systems enumerated. F.P.H.

Hydraulic limes and gypsum from lignite ash. HEINRICH LUFTSCHITZ. *Tonind. Ztg.*, **53** [4], 64–65 (1929); *Rock Prod.*, **32** [20], 88 (1929).—It is possible to produce hydraulic limes and gypsum from the ash residue of lignite or brown coal. The ashes are calcined at about 2300°F and ground in a ball mill to leave a 15 to 18% residue on the 175-mesh screen. One of the samples so treated gave a product analyzing 44.5% CaO and 29.44% SO_3; mixed with sand (1:3) and specimens stored in air for 28 days, then broken in the usual way it showed strength of 3700 and 4380 lb./in.^{2} Coal ashes high in silica produced a good hydraulic lime with all the usual properties. If limestone is added to the boiler ash, just as it comes from the boilers, and the whole ground and calcined, there results a good hydraulic lime. Much of the SO_3 in these ashes is converted if the calcining takes place in an excess of air. F.P.H.

Accelerators and retarders for gypsum. P. P. BUDNIKOFF. *Zhur. Prikladnoi Khim.*, **1**, 323–27 (1928).—Addition of acids, bases, and normal and double salts to gypsum affects the character of the time-temperature curves during the process of setting. This can be explained by the increase or decrease of the solubility of gypsum and by the change in the rate of coagulation of the gel. It can also be due to formation of double compounds and to the reactions which may occur between gypsum and the added substances. (*C.A.*)

Portland cement moduli. HESS. *Zement*, **18** [2], 227–30 (1929); *Rock Prod.*, **32** [20], 88 (1929).—The hydraulic modulus of Portland cement is of prime importance in correcting the raw mix or in the graphic representation of the four-component system, according to H. All regularities which could possibly be found with the four-component system: CaO, SiO_2, Al_2O_3, and Fe_2O_3, which was used as a basis, were obtained, divided into six groups according to the different constant and nonconstant relations, and investigated by graphic representation on the tetrahedron, each case having been obtained mathematically from a Portland cement with a hydraulic modulus of 2.00, and a graphic representation prepared for each. Thereby the extremes of each individual case take on compositions which are no longer Portland cements, but each regularity in the graphic representation must pass through the Portland cement point from which the start was made; this operating method has the advantage that the position of a plane or a line can be determined more accurately and wholly. F.P.H.

Steam curing of Portland cement mortars; a new crystalline substance. T. THORVALDSON AND G. R. SHELTON. *Can. Jour. Research*, **1** [1], 148 (1929).—The steam curing of Portland cement mortars in saturated steam at 100°, 125°, 150°, 175°, and 200°C was studied both as to variations in the tensile strength of 2-day and 28-day mortar briquets and as to the changes which occur in the crystalline matter in the cement. The rate of hydration of the cement, as shown by the disappearance of the original crystalline material, increased with the temperature of the saturated steam. Crystals of calcium hydroxide appeared almost at once, but after reaching a maximum decreased again in amount. At the same time, a new crystalline product appeared and increased in quantity as the amount of hydrated lime decreased. Some of the chemical properties of the new crystals are given. The stability of the new crystals when exposed to solutions of sulphates indicates that the great increase in the resistance of Portland cement mortars to alkali action, produced by steam curing, is connected with the production of this crystalline material. W.L.

Volumetric changes in Portland cement mortars and concretes. RAYMOND E. DAVIS AND G. E. TROXELL. *Proc. Amer. Concrete Inst.*, **25**, 210–60 (1929).—The work has extended over a period of nearly 4 years and at present more than 400 concrete and mortar specimens are under observation. The test program includes richness of mix, gradation of aggregate, quantity of mixing water, character of aggregate, moisture conditions, including variations in humidity, conditions of curing, the effect of alternat-

ing periods of watersoaking and drying, the effect of admixtures, and the effect of the surrounding medium. (*C.A.*)

Marketing of gypsum products. R. M. SANTMYERS. Bur. Mines, *Information Circ.*, No. 6157, 26 pp. (1929). R.A.H.

Canadian gypsum industry. R. M. SANTMYERS. Bur. Mines, *Information Circ.*, No. 6162, 27 pp. (1929).—Details are given relative to the nature of the deposits, methods of production, costs, etc., of the various producing localities. R.A.H.

Concerning alite. E. JÄNECKE. *Zement*, **17** [45], 1626–27 (1928); *Rock Prod.*, **32** [19], 90 (1929).—J. defends himself against H. Kühl (*Ceram. Abs.*, **8** [10], 709 (1929)) by reviewing some of his experimentally obtained data. F.P.H.

Continuity of experiment in cement testing. EDITORIAL. *Engineering*, **128**, 235–36 (1929).—Consequences of working either without regard to standard conditions or of defining and adhering to them too strictly, are discussed with reference to two recent government reports. H.H.S.

Relation between composition and strength of cements. III. SHOICHIRO NAGAI. *Jour. Soc. Chem. Ind.* [Japan], **32** [1], 29 (1929); *Tonind.-Ztg.*, **53** [33], 464 (1929); for abstract see *Ceram. Abs.*, **8** [8], 560 (1929). F.P.H.

PATENT

Water glass. KALI-CHEMIE A.-G. AND HANS BRENEK. Ger. 477,974, Feb. 20, 1924. Rock containing alkali and alumina is subjected to smelting or sintering and the smelt treated with acid after chilling. The resulting H_2SiO_3 is dissolved in NaOH. (*C.A.*)

Enamels

Work of the Bureau of Standards Enamel Section. W. N. HARRISON. *Enamelist*, **6** [4], 18–22 (1929).—Harrison gives a résumé of the work being carried out at the Bureau of Standards in the studies of enameling problems. The researches have gradually shifted from the solution of specific problems to those of more fundamental nature. The section welcomes calls for help in trouble finding and is glad to render any aid possible. A complete bibliography of publications is included. G.H.McI.

Fishscaling. ANON. *Emaillewaren-Ind.*, **6** [34], 275–77 (1929).—Fishscaling can be traced to various sources. One kind may appear shortly after ground-coat firing, during drying of the second coat, or after firing of the second coat. Nonpenetrating fishscales are due to greater tension in the layer surpassing the compressive strength of the enamel; they depend on elasticity, expansion, thickness, and temperature difference. The greater the difference in expansion or the smaller the expansion of the enamel, the sooner will the compressive strength of the enamel be exceeded. Thick sheets of less elastic metal increase the forces and tend to fishscale. Neither the metal nor the enamel can be the sole cause. The mixture may be faulty or the ground coat favor fishscaling after repeated firing. Fishscaling may also occur at the metal surface or where adhesion is lacking. The possibility of a uniformly adhering enamel is unquestionable due to reductions during firing, especially with nickel oxide. For this reason, oxidizing agents should be added. Nickel ground coat, because of its low fusibility, often receives quartz and the latter can be seen within the fishscales. T.W.G.

Aging of enamels. ANON. *Amer. Enameler*, **2** [3], 3–4 (1929).—Copperheads and fishscales were found to be due to insufficient aging. E.R.

Some causes of dirt in enamel. BRUCE F. WAGNER. *Enamelist*, **6** [6], 30–40 (1929).—A full discussion of the general causes of dirty enamel is given with suggestions for their elimination. The main sources of dirt come from the frit, clay, mills, pebbles, and air used for spraying. The shop itself should be kept absolutely clean. G.H.McI.

Shot, grit, and sand. CHARLES BOULTMAN. *Amer. Enameler*, **2** [5], 3–5 (1929); *ibid.*, **2** [6], 13–14 (1929).—A discussion of the growing use of steel abrasive in enameling plant hygiene and efficiency is given. It is estimated that one ton of steel abrasive does the work of a carload of sandblast sand. E.R.

Steel grit vs. sandblast sand. CHARLES BOULTMAN. *Enamelist*, **6** [9], 38 (1929).—Angular steel grit must be used under conditions suitable to it to be successful in operation. In one plant where a few minor changes were made, the cost for steel-grit operation was $0.00043 per lb. as against $0.002175 per lb. with sand. G.H.McI.

Cast-iron and porcelain enameling. H. G. WOLFRAM. *Amer. Enameler*, **1** [4], 3–6 (1928).—The practical reason for coating metal is to prevent corrosion. The esthetic reason is to dress up otherwise bare and unattractive metal. Blistering and its causes are discussed. E.R.

Application of majolica enamels. FRANZ NOVAK. *Amer. Enameler*, **1** [9], 4 (1928).—A ground coat with a high covering capacity (preferably white) should be made of No. 005 glass with 5% clay and 15% tin oxide milled fine, and should be fired to 1225°F. The correct temperature for firing majolica is 1175°F; too high a fire will cause dullness, too low a fire, blisters. E.R.

Screen tests. ANON. *Amer. Enameler*, **1** [9], 3–4 (1928).—Screen tests eliminated trouble with rust after dipping. E.R.

Suggestions for designers. H. M. BADGER. *Enamelist*, **6** [9], 28 (1929).—Castings should be designed to give even heating and cooling thereby reducing chipping, hairlining, and crazing to a minimum. The same consideration holds for sheet-steel parts. Electric spot welding should be done with a minimum amount of current advisable for a good weld. Heavy angles or brackets should not be welded to the under side of a sheet-iron part to be enameled. G.H.McI.

Acid-tank construction and mechanical pickler. ANON. *Blast Fur. Steel Plant*, **17** [9], 1382–83 (1929).—An improved construction for acid vats for pickling, plating, and similar operations, and for the storage of acid in quantities, has been perfected by the Nukem Products Corp. (Buffalo, N. Y.), and is known under the trade name of "Basolit." F.P.H.

Microscope in control of vitreous porcelain enamel. J. T. IRWIN. *Enamelist*, **6** [6], 18–28 (1929).—The many applications of the microscope to enamel-making control and research are discussed in some detail. Qualitative microchemical methods for the identification of feldspar, quartz, cryolite, fluorspar, calcspar, zinc, and lead oxides, as well as oxides of nickel, chromium, cobalt, manganese, and iron are given. The determination of free quartz in feldspar is also discussed. The microscope may also be advantageously employed in the control of smelting, burning, and general trouble shooting. Examples are given. References to printed works are included. G.H.McI.

Electric enamel furnace. A. D. DAUCH. *Amer. Enameler*, **1** [3], 6–7 (1928).—Means for compensating heat losses at the door or loading end are of major importance. The size of the furnace should be studied carefully. E.R.

Influence of clay upon steel furnace flux. GEORGE MARS. *Stahl Eisen*, **49** [37], 1339–40 (1929).—Half of the lime content of the flux was replaced by clay in form of fired bauxite maintaining the usual 10 to 15% SiO_2 content. With de-phosphorizing fluxes rich in clay and with the usual lime fluxes there will be an FeO surplus as well as a low temperature of the bath. The assumption that clay in reference to phosphoric acid would act as a base is not substantiated. In desulphurizing by argillaceous fluxes the usual rules of high temperature and reducing treatment hold good. Similar laws hold for de-oxidation of steel with argillaceous fluxes. Trials have shown the practicability of a lining of 90% CaO and 10% Al_2O_3. Such a furnace permits de-phosphori-

zation, with pure lime flux taking up but little clay from the furnace without losing the ability to take up phosphoric acid. T.W.G.

Ovens for fusing enamel. ANON. *L'Émail*, **1** [8], 33–34 (1929).—The rotary kiln used for the fusion of enamels is discussed and data are given on fuel consumption, output, cost, etc., of a German installation. T.W.G.

Continuous furnace test. ANON. *Enamelist*, **6** [7], 10–13 (1929).—A furnace of the closed-end, cross-fired, U-type, continuous design, in which two different types of flue construction were incorporated, was used in determining the more economical method of firing under similar operating conditions. In the case of flue construction in which the combustion gases are carried to the front of the furnace to be used in preheating the incoming load, the average gas consumption was 8865 cu. ft. per hr. When the gases were discharged directly above the furnace without being further used for preheating, the gas consumption averaged 10,865 cu. ft. per hr. At the same time it was found necessary to reduce the chain speed after two hours' operating to keep up the temperature. Thus a saving in fuel can be effected by using the waste gases to preheat the incoming ware. G.H.McI.

New method for increasing production. GEORGE W. GREENE. *Enamelist*, **6** [7], 20–21 (1929).—In checking up on production operations, it was found that much time and heat were lost in operating the forks and doors of the double-end box type furnaces by hand. By equipping the furnaces with electrically-operated doors and forks, it was found possible to lower the time of the charging cycle from 25 to 30 sec. down to 12 sec., giving from 16 to 18 loads per hr. as compared to 10 or 12 by hand. G.H.McI.

Continuous heat treatment of sheet metal. EDWARD S. LAWRENCE. *Blast Fur. Steel Plant*, **17** [9], 1346–49 (1929).—Continuous heat-treating equipment is described. F.P.H.

Combustion tunnel sprayer-drier units in enameling plant. ANON. *Ceram. Ind.*, **13** [4], 374–80 (1929).—A prominent St. Louis enameling plant has developed a method of enamel application by means of four combination tunnel sprayers and driers. This system is flexible, has cut costs, reduced the amount of labor to about one-half that formerly used, speeded up production, saved floor space, and has obtained a more uniform coat of enamel on the ware. Some of the features incorporated are patented. F.P.H.

Cast iron used for enameling. A. MÜLLER. *Giesserei Ztg.*, **26**, 247–50 (1929).—The ratio of shrinkage between cast iron and enamel increases with increasing C and Mn contents, and decreases with increasing Si and P contents. Graphite-rich irons show a smaller shrinkage than graphite-poor irons. Shrinkage in hot-cast pieces is smaller than in cold-cast pieces. Cast iron of the following composition may be enameled: C 3.6–3.7, Si 2.3–2.6, Mn 0.6–0.9, P 0.6–0.9, and S 0.08–0.1%. For previous abstract see *Ceram. Abs.*, **8** [8], 564 (1929). (*C.A.*)

Treatise on 451 Leadless. HARRY C. GOUDY, SR. *Amer. Enameler*, **1** [5], 3–6 (1928).—Burning temperature of "451" on sheet iron is 1350°F; 541–28 is recommended for white and light grays. The analyses of mill additions and standard fineness are given. It is important to use little water with 451 when milling; 451 should be aged several days; 451–21F will give clear colors; 451–27B gives jet in one coat. The blistering point is well over 1000°F. H. C. GOUDY, SR. AND P. T. SEALEY. *Ibid.*, **1** [12], 13–14 (1929).—A study of a leadless enamel "451," so-called because it was perfected after 451 trials. The following characteristics are attributed to "451" as made by the Porcelain Enamel & Mfg. Co.: (1) contains no poisonous materials, (2) has more resistance to physical and thermal shock; (3) no special handling, and (4) easier to spray than other enamels. E.R.

Spray gun (answers to questions). ANON. *Amer. Enameler*, **1** [3], 16 (1928).—

(1) Liquid-colored enamels will not change color in the course of aging in the mill room. Southern pig iron is softer than northern and will therefore cause the enamel to fuse more readily. (2) The castings need not be poured hot provided the iron is perfectly fluid. (3) Blistering always results if black edge is applied too wet or too heavy. *Ibid.*, **1** [4], 12–13 (1928).—(1) Casting should be uniform in cross-section from a chemical analysis point of view as well as from a metallographic standpoint. (2) Companies using steel grit for sandblasting adhere closely to the following rule: Sandblast steel shot should be used in the ratio of 80% to about 20% of sandblast sand; steel shot should not be used on castings to be covered with porcelain enamel. *Ibid.*, **1** [5], 17–19 (1928).—(1) The improper cleaning of ware before pickling produces the following defects: crawling, blisters, improper bond of ground coat to metal, boiling of absorbed acid, and copper spots. (2) The average temperature used for firing enamels is 1500 to 1600°F. (3) On sheet iron the consumption of enamel should be 30 lbs. per 100 sq. ft.; on cast iron, 3 to 8 lbs. per sq. ft.; 30% less is needed with "451" leadless. (4) For spraying, girls are more efficient on light castings and sheet-metal parts, and men are more efficient on large parts and heavy castings. (5) It is possible to convert a gas or oil furnace into an electric furnace provided that the crown is in good condition. *Ibid.*, **1** [6], 11–12 (1928).—(1) The cost of enameling a gas stove is usually 15 to 25¢ per sq. ft. The average range contains 15 sq. ft. of enameled parts. Discounts should not run over 3% (enamel shop and mounting included). *Ibid.*, **1** [9], 11–12 (1928).—(1) When and where was the first wet-coat enamel used on stove castings? This question can be answered by referring to a paper by H. F. Staley. (See "Developments in enameling technology during the past 25 years," *Jour. Amer. Ceram. Soc.*, **6** [1], 240 (1929)). Karl Turk was one of outstanding men in the development of enameling technology and S. F. Blatt, one of the first users. *Ibid.*, **2** [2], 14 (1929).—(1) Gas holes are due to the condition in which the casting is made. The remedy recommended is to sandblast thoroughly and burn out at higher temperature, then re-sandblast. *Ibid.*, **2** [3], 12–14 (1929).—(1) Barreled enamel frit is moist but the frit manufacturers always make an accurate and fair allowance for moisture. Barrels are much stronger than bags and they reduce waste to a minimum. (2) An orange peel effect is caused by faulty composition of frit and too low air pressure in the spraying line. Hard enamels, as well as those coarsely ground are apt to orange peel. (3) Fishscaling and copper heads are invariably caused by the failure to age the enamel. *Ibid.*, **2** [5], 16 (1929).—Iron in wet enamel is generally caused from worn out mill linings. The wet-type magnetic separator is recommended for removing this iron. *Ibid.*, **2** [6], 16 (1929).—(1) Screen tests have supplanted the old rule-of-thumb tests for fineness. (2) Underfired enamel can be detected by rough finish and lack of gloss or small blisters; overfired enamel is indicated by pitted and spongy appearance and black spots. E.R.

Preparation and standardization. THEODORE LENCHNER. *Amer. Enameler*, **2** [2], 10 (1929).—The commercial manufacture of coloring oxides used in enameling was introduced in the U.S. by F. Roessler (Perth Amboy, N. J.). Ceramic color was previously imported from Europe. Hues complementary to color must be avoided. Variations in color are corrected by blending. Pyrometers, regulators, automatic timing, and stopping devices assist in this work. E.R.

Off-shade in color. ANON. *Amer. Enameler*, **2** [6], 13–14 (1929).—Off-shades are caused by carelessness in cleaning and washing the mill if the same mill is used for different colors. *The Ready Remedier* gives recommendations for this work. E.R.

Matching color. H. C. GOUDY, SR. *Amer. Enameler*, **2** [3], 8 (1929).—At the meeting of the AMERICAN CERAMIC SOCIETY in Chicago, the Munsell color system was discussed. The three dimensions of hue, value, and chroma will fully describe any hue or shade. E.R.

Coloring. ANON. *Amer. Enameler*, **2** [4], 8–9 (1929).—The development of artistic sense in coloring stoves and refrigerators is urged. E.R.

Colored enamels. HANS MELZER. *Glashütte*, **59** [37], 664–66 (1929).—Discussion of methods for the manufacture of light colored enamels. L.T.B.

White enamel. HANS MELZER. *Glashütte*, **59** [36], 646–49(1929).—Discussion of various materials used in making white enamel with a notation of the advantages and disadvantages of each one noted. L.T.B.

One or two white coats. ANON. *Emaillewaren-Ind.*, **6** [37], 301–302 (1929).—While generally for white enameling three coats (including the ground coat) and three firings are needed, attempts have been made to omit one coat to save one-third the labor. It is concluded that the decision rests with each factory. An accurate account would reveal that nothing is gained by single coating. T.W.G.

Manufacture of enamel watch dials. ROBERT J. GUNDER. *Enamelist*, **6** [5], 30–38 (1929).—Gunder describes briefly the steps involved in the manufacture of watch dials. The enamel used is a high-grade French enamel which is delivered in cake form. This is carefully ground to a fine texture, washed, dried, and dusted onto the copper disks used for the base metal of the dial. The burning operation is carried out in a small electric furnace and the process carefully timed to prevent discoloration. After cleaning and buffing, the dials are highly polished. G.H.McI.

Enamels on automobiles. H. LEE HOFFMAN. *Amer. Enameler*, **2** [1], 3–4 (1929).—H. thinks that enamel will be used by all automobile manufacturers within the next few years. Porcelain enamel will aid sales, resale values, insulation of heat, and cleanliness. E.R.

Washing machines as new field for porcelain enamel. H. L. BROOKS. *Enamelist*, **6** [8], 6–8 (1929).—Since the rise in the price of copper, much experimenting has been done to produce a sheet-iron washing machine tub which may be enameled. Steel used for such a purpose is rigid and tough compared with the softness of copper. The enameled surface is free from corrosion and stains, as well as free from attack by alkalis and salts. The cost of the enameled tub is about one-half that of the copper. G.H.McI.

Handling enamelware. WM. WOLFF. *Amer. Enameler*, **2** [4], 3–5 (1929).—A jacklift truck for handling ware has been adopted by Walker & Pratt Mann Co. The system permits turning out different colors at the same time. E.R.

Packing enameled ranges for export. THOMAS E. LYONS. *Amer. Enameler*, **2** [6], 3–7 (1929). E.R.

Enamel plant savings. ANON. *Amer. Enameler*, **1** [6], 3–4 (1928).—The new manager of a large plant discusses the output with his workmen and discovers that sulphuric acid is lowering production. By changing over to muriatic acid, the manager has saved thousands of dollars. E.R.

The stove business. P. R. SCOTT. *Amer. Enameler*, **1** [6], 5–8 (1928).—The 3rd of a series of biographical sketches of men and companies well known in the stove industries. The New Scott Range Mfg. Co. (New Zealand), its early difficulties, and present hopes are discussed. E.R.

Lead hazard in enameling. EDITORIAL. *Amer. Enameler*, **2** [4], 6–7 (1929).—The dangers of lead are discussed by W. S. Leathers, Hugh J. Morgan, and the U. S. Dept. of Labor. E.R.

Enamel sanitary-ware manufacture. ALICE HAMILTON. *Jour. Ind. Hyg.*, **11**, 139–53 (1929).—Health hazards are discussed. (*C.A.*)

Cryolite. ANON. *Mineral Ind.*, **37**, 227 (1928).—Cryolite, a mineral having the composition Na_3AlF_6, is mined only at Ivigtut, Greenland. Shipments are made by the mine operators only to Denmark and the U.S. E.P.R.

Early Russian enamels. CYRIL G. E BUNT. *Connoisseur*, **84** [337], 148 (1929).—A brief historical sketch of enameled ceramic art ware with the names of the collections. (Illustrated.) T.W.G.

Shadow of the pyramids. A. I. ANDREWS. *Amer. Enameler*, **1** [3], 5 (1928).—The origin of enameling can be traced back to the era before Christ. The Egyptians were the first to make enamels. The name "enamel" was first called "electron" as used by Homer. E.R.

Byzantine period. A. I. ANDREWS. *Amer. Enameler*, **1** [4], 15–16 (1928).—The origin of porcelain enameling is unknown, but its greatest development occurred during the Byzantine period, at which time cloisonné and champlève were made. E.R.

Champlève enamels. A. I. ANDREWS. *Amer. Enameler*, **1** [5], 14–15 (1928).—Copper smiths used a process called champlève for enameling bronze, copper, and other heavy metals. The first real progress in enameling took place at Byzantium. There is a decided Persian influence. The art was introduced into Great Britain after the Roman Conquest. It was well established in Germany in the 12th Century. Limoges, during the Middle Ages was the center for fine enameling. E.R.

BOOK

Foundry Practice. Vol. III. (Handbuch der Eisen- und Stahlgiesserei.) C. GEIGER. 2nd ed. Julius Springer, Berlin, 1929. Price 68.50 Rm. This third volume deals with the melting of iron and steel, the subsequent treatment of the castings, and the various accessories of a foundry. Reviewed in *Engineering*, **128**, 224 (1929). H.H.S.

PATENTS

Manufacture of tile and brick. WILLIAM HOGENSON. U. S. 1,728,934, Sept. 24, 1929. A metal strip for use in the manufacture of tile and brick articles, the strip having spaced raised portions simulating tile or brick and connected at the bottom of the raised portions by relatively weak connecting members, the entire strip being provided with a surface portion composed of vitreous enamel.

Alkaline earth titanates. REGINALD H. MONK. Fr. 655,399, June 5, 1928. A pigment consisting of alkaline earth titanates is prepared by heating precipitated $Ti(OH)_2$ free from SO_4 to 750–880° with an alkaline earth carbonate in the presence of an accelerator such as HCl or an alkaline earth chloride. The SO_4 is eliminated by treatment with NaOAc or NH_4OAc and washing. (*C.A.*)

Enamelware. I. G. FARBENIND. A.-G. AND EISENWERK KAISERSLAUTERN A.-G. Ger. 477,721, Dec. 20, 1927. Cast- and wrought-iron objects are subjected to a vacuum during or after the application of the enamel coating, and are then re-subjected to atmospheric pressure. (*C.A.*)

Enamels and glazes. DYNAMIDON-WERK ENGELHORN & CO. G.M.B.H. Ger. 477,800, Nov. 18, 1927. The resistance of enamels and glazes to chemicals is increased by addition of sillimanite or corundum. (*C.A.*)

Glass

Speed of crystallization of soda-lime-silica glasses. ADOLF DIETZEL. *Sprechsaal*, **62** [28], 506–509; [29], 524–25; [30], 543–44; [31], 562–68; [32], 584–85; [33], 603–604; [34], 619–21; [35], 638–39; [36], 657–60(1929).—First installation was briefly reviewed (see *Ceram. Abs.*, **8** [11], 799 (1929)) and the conclusion brings out the following point: (1) 24 melts were made at 2% intervals between 6% CaO·12% Na_2O, 16% CaO·12% Na_2O, 6% CaO·18% Na_2O, and 16% CaO·18% Na_2O. The glass melts were made in platinum crucibles from pure raw materials and made homogeneous through one melting. 0.25% Na_2O was previously added to compensate for loss dur-

ing melting. (2) Speed of crystallization was determined for each glass at various temperatures. (3) The eliminated compounds were mainly cristobalite and wollastonite and to a smaller extent tridymite, pseudo-wollastonite, and twin-silicate $Na_2O \cdot 3CaO \cdot 6SiO_2$. The latter was found by X-ray method and the others microscopically. (4) To determine the influence of heat passage upon the speed of crystallization, a $Na_2O \cdot 3CaO \cdot 6SiO_2$ glass from the field of permanency was melted in various ways, the devitrification of them all producing cristobalite and wollastonite with practically the identical speed of crystallization. (5) The relationship between toughness and speed of crystallization curve is pointed out. The temperature above which the devitrification trials change their shape usually coincides with the lower devitrification limit, *i.e.*, that temperature above which the speed of crystallization assumes doubtful values. The toughness at this temperature according to diagrams by Washburn and Shelton is about 10 poises. The speed of crystallization curve retroverses abruptly with short limey glasses on account of a sudden change of toughness. (6) The speed curves of crystallization for the various glasses in a diagram like Zschimmer's four-pointed diagram. In glasses rich in sodium oxide, *e.g.*, 18% Na_2O, 8% lime acts favorably on glassiness or vitrification while higher lime quickly increases devitrification. The reverse is the case with glasses poor in sodium (12% Na_2O) where lime is acting favorably up to 12%. (7) By plotting the temperature of maxima speed of crystallization and the shortest devitrification periods, a curve representing all the glasses of relative high-speed maximum was found to be $y = 23.3 - 0.79x$, where x represents the sodium and y the lime content. Another curve is obtained representing the compositions of glasses which crystallize the slowest, having the equation $y = 27.7 - \sqrt{62x - x^2 - 422}$. This line of greatest vitrification has a special practical value. Neither line fully coincides but the lines intersect at a sharp angle. As an approximation, a mean average of the curves was developed as a line with the equation $y\%$ CaO $= 26 - x\%$ Na_2O, *i.e.*, the combined sodium and lime content of practical sodium-lime-silica glasses must be 26%.

T.W.G.

Identification of the softening range of glasses and the abnormal changes of the specific heat and volume of glasses in the softening range. G. TAMMANN AND A. KOHLHAAS. *Z. anorg. allgem. Chem.*, **182** [1], 49–73 (1929).—The authors have shown that the softening range of glasses is limited by two definite temperatures which can easily be determined for low-melting glasses. Within this range there is a decided abnormality in both the specific heat-temperature and the volume-temperature curves.

L.T.B.

Microscopical examination of glass. L. SPRINGER. *Glass*, **6** [9], 386–89 (1929).—Microphotographs of the following are given: (1) stony glass, (2) devitrified glass, (3) decomposed glass, and (4) cloudy glass cylinder.

O.E.M.

Coloring incandescent lamps on the inner surface. A. F. LINDSTROM. *Chem. Met. Eng.*, **36**, 410–11 (1929). (*C.A.*)

Coloring of glass by bismuth. II. KITSUZO FUWA. *Mazda* [Japan], **3**, 295–324 (1928)(in English).—Basic Bi carbonates and Bi nitrates added to glass or porcelain produce a color that depends upon the composition of the glass. Upon heating, the glass turns deep brown, gray, or milk-white. With KNO_3 as oxidizing agent, the color is light and its nuance depends upon the composition of the glass. If K tartrate is used as the reducing agent, no marked color is obtained. With arsenious acid the coloration is weakened, probably by the precipitation of metallic Bi. For Part I see *Ceram. Abs.*, **8** [6], 408 (1929). (*C.A.*)

Shrinking of glass threads on heating. IKUTARO SAWAI AND YOSHIHIRO UEDA. *Z. anorg. allgem. Chem.*, **180**, 287–303 (1929).—Glass threads of the composition 75.00 SiO_2, 2.83 R_2O_3, 6.43 CaO, and 15.40% Na_2O and varying in diameter from 0.316 to 0.031

mm. were heated at various temperatures and under various loads. From observations of the rate of elongation or shrinking, viscosity, and surface tension could be calculated by the formula $-ln(l_0/l) = [t/(\pi r^2_m \lambda)][2\pi r_m \alpha - (m + (M_0/2))]$, where l_0 is the original length, l the final length, t the time, r_m the mean radius of the thread, λ the coefficient of viscous traction (see F. L. TROUTON, *Proc. Roy. Soc.*, **77**, 426 (1906)), α the surface tension, M_0 the weight of the thread, and m the load on the thread. The surface tension varied from about 15 mg./mm. at 600° to about 11 at 800° and λ from 1.5×10^6 to $7.4 \times 10.^2$ (*C.A.*)

Strontium and its uses. ANON. *Engineering*, **128**, 264 (1929).—Although Sr is present in many rocks and minerals, practically the only sources in industry are celestine ($SrSO_4$) and strontianite ($SrCO_3$). The uses of Sr are in beet-sugar refining, pyrotechnics, and iridescent glass. English deposits of celestine supply practically the entire requirements of all countries, including the U.S. H.H.S.

Industrial application of vanadium. JEROME ALEXANDER. *Chem. and Ind.*, **48**, 871–78, 895–901 (1929).—The first large deposits of V ore were discovered by Riza Patron in 1905 in the Peruvian Andes. Metallurgical methods were invented by B. D. Saklatwalla. The chemistry of V is as complex as that of C. In ceramics V is used as a glaze color, and in glass as a preventative of deleterious rays. Spectrophotographs of V and other glasses are given. The V atom seems to be of just the right size to block out the objectionable section of the spectrum. H.H.S.

Borax in the glass industry. ANON. *Can. Chem. Met.*, **13** [9], 40 (1929).—One of the more important recent applications of borax is in container glass. Borax and boric acid increase the tensile strength, thermal endurance, and chemical resistance of the glass. The time for melting and fining the glass is reduced, and the yield is greater and more free from defects. Boric oxide has a successful application in laboratory ware, electric bulbs, thermometers, etc., and in window glass, permitting the transmission of ultra-violet rays. E.J.V.

Window materials and fabrics for transmitting ultra-violet radiation. W. W. COBLENTZ. *Glass Ind.*, **10** [10], 233–36 (1929).—The following topics are discussed: (1) an estimate is obtained of the amount of the short wave-length ultra-violet solar radiation that is shut out by common window glass; (2) statistical data are given on the transmissive properties of various newly-developed window glasses and glass substitutes for transmitting the short wave-length ultra-violet solar radiation; also data on the decrease in transmission that these glasses undergo on exposure to the sun and to artificial sources of ultra-violet radiation; (3) data are given on the transmission of fabrics, and the reflection of paints, for ultra-violet radiation. E.J.V.

Hygienic effects of ultra-violet radiation in daylight. HENRY PHELPS GAGE. *Glass Ind.*, **10** [10], 238–42 (1929).—This is an endeavor to find what benefits can be expected from ultra-violet irradiation, and especially that due to the intensity of ultra-violet contained in sunshine. The work at Cornell University was frequently observed. E.J.V.

New ultra-violet ray transmitting glass. ANON. *Glass Ind.*, **10** [10], 254 (1929).—An improved ultra-violet ray transmitting window glass called Uviol-Jena has been announced by Fish-Schurman Corp., agents for Schott & Gen. (Jena, Germany). The new glass transmits 70.5% before solarization and 51.5% after solarization at a wave-length of 302μ. E.J.V.

Value of laminated glass. ANON. *Nat. Glass Budget*, **45** [22], 23 (1929).—To keep particles and slivers from being projected into the air in case of a break, the adhesion between the glass and the pyroxylin plastic must be such as to prevent separation of the glass from the pyroxylin plastic upon impact. E.P.R.

Quartzous glass sands and their application in the glass industry. I. I. GINSBURG

AND I. F. HECKER. U.S.S.R. *Comité Géologique; Materials for General and Applied Geology* [Leningrad], No. 93, 46 pp. (1928).—Quartenary sands, as well as sands of older formation (Tertiary, Jurassic, Devonian, and Silurian) are used as raw material in more than one-half of all the glass factories in the European part of the U.S.S.R. Quarternary sands are used especially in the central industrial region in White Russia and Volhynia; the Tertiary sands in the Ukraine and Caucasus, the Jurassic in the vicinity of Moscow, and the Devonian and Silurian sands near Leningrad. Deposits of Quarternary sands are worked mostly by peasants; thus their production is not very high. The output of sands of older formations is made on a high scale and sands necessary for manufacturing high quality glass are often delivered to glass factories from remote places. These sands are usually of more homogeneous composition, contain a high percentage of SiO_2 and have only a small admixture of Al_2O_3 and Fe_2O_3. Mechanical composition of Quarternary sands is not uniform and is uncertain, the size of grains being from 0.50 to 0.25 mm. The size of grains of older sands is smaller, from 0.35 to 0.05 mm., and more uniform. The output in the Central and Northern districts reached in 1925 to 1926 about 30,000 T. of old sands and about 63,000 T. of Quarternary sands. The highest consumer of glass sands is the Central district; then follows the Ukraine, and finally the Northern district. From the whole output of glass sands, which reaches about 181,000 T. about 123,000 T. are used by factories working ordinary bottles and window glass. The price for the best glass sands is from $1.25 to $9 per ton. The sands are sold undressed and the factories themselves sieve and sometimes wash them. A map of European Russia showing the distribution of the main 77 glass factories in the country and the 17 regions of deposits of glass sand are given. The kind of fuel used by the factories is mentioned in the map. W.A.

Chemical glassware manufactured by the Russian governmental plant "Druzhnaya Gorka." V. E. TISHCHENKO. *Zhur. Prikladnoi Khim.*, **2**, 3–19 (1929).—Chemical resistivity of this glass is superior to any other grade of chemical glass manufactured in other countries, though it is less resistant to heat than Jena glass and especially Pyrex. (*C.A.*)

Glass as a strain detector. T. W. TALWALKAR. *Jour. Ind. Ceram. Soc.*, **1** [3], 80–81 (1929).—In the famous Kutubminar (Delhi, India), a huge stone tower of the 12th Century, it is said that each stone is fastened to the adjoining stone by metal, probably copper strips. To detect any separation of stones from each other, the engineers have used a novel method of putting glass plates over the joints and cementing the ends to adjoining stones, with the expectation that should any strain occur due to separation the glass would crack immediately and thus give warning. T. criticizes this device on the ground that glass being a viscous substance would yield to gradual strain and there may be an appreciable flow to cause the relief of the strain. A.A.

Glass cutters. ANON. *Nat. Glass Budget*, **45** [24], 12 (1929). E.P.R.

Flint glassware made by automatic machine methods. ANON. *Nat. Glass Budget*, **45** [24], 23 (1929).—There is a growing tendency toward the automatic production of crystal and colored tableware and bar goods. Several lines are now being made most successfully by the machine method, especially in mass production. E.P.R.

Finishing glassware by power tools. ROBERT SCHEIDWEILER. *Sprechsaal*, **62** [31], 569–70 (1929).—Hand and electric power tools for cutting and finishing glassware are described and illustrated. T.W.G.

Conveyer for carrying bottles from bench of furnace to baking furnace. D. P. ORLOV. *Ceramics and Glass* [Moscow], **3**, 71–73 (1929).—O. constructed a conveyer which can be operated without the necessity of special power, the bottles being moved by their own weight along the inclined plane over small rollers. The length of the conveyer is 8 m., the height at the bench 1.38 m. The conveyer ends with a narrow

opening into which the neck of the bottle enters. To prevent the cooling of the bottles the walls are lined with asbestos. The angle of inclination of the conveyer can be changed according to the kind of bottles manufactured. The last part of the conveyer is made horizontal. A too high speed of the movement of the bottles is reduced by this arrangement. The cost of the conveyer is about $100. Schematical design of the conveyer as well as figures showing the amount of money saved by using it are given. W.A.

Polarization apparatus of the simplest construction. M. A. BESBORODOV. *Ceramics and Glass* [Moscow], **3,** 73–75 (1929).—A simple polarization apparatus by which the tempered glass can be examined is described. Its main advantage consists of its simplicity, cheapness, and possibility of its construction by the factories themselves without the necessity of using nickel prisms which are usually hard to get. Besides no specially qualified personnel is required for its operation. Its principle is based on the fact that a light ray polarized under certain adjustment passes through the glassware to be examined and then is polarized again under another adjustment in the plane perpendicular to the first plane of polarization; reaching the eye of the observer the latter can immediately determine the degree of the tempering of the glass. A schematical design of the apparatus showing its main dimensions as well as the path of the light ray is given. Tests of the apparatus have proved its suitableness for examination and control of the tempering of ordinary glass, assorted glass, and especially of sheet glass. W.A.

The glass container at Orrefors. THEODORE WOLFRAM. *Ceram. Ind.*, **13** [4], 362–66 (1929).—A description is given of the methods of manufacture of glassware used at the Orrefors Glass Works (Sweden). Orrefors glass may be classified according to the composition of the glass mixture as potash-lead glass, so-called crystal glass, manufactured at the Orrefors Glass Works, and soda glass, manufactured at the Sandvik Glass Works of the Orrefors Co. Both of these kinds of glass are melted in pots, the crystal glass in a tank furnace and the soda glass in a furnace equipped with recuperators. Wood is used as fuel. The molten glass is worked at the furnaces entirely by hand without any sort of mechanical aids. All hollow parts are blown and solid parts like the leg and foot of wine glasses, handles on decanters, pitchers, and so forth, are shaped and fitted of hot glass with the aid of hand implements, shears and tongs of the simplest shape and most primitive description. The engraver's only tool is the revolving copper wheel. F.P.H.

Modern glass-forming machinery. ANON *Engineering*, **128,** 304–305 (1929).—The concluding article of the series (see *Ceram. Abs.*, **8** [10], 721 (1929)) shows photographs and diagrams of the Fourcault sheet-glass process at Jeumont, France. H.H.S.

Manufacture of wire glass. IV. JOSEPH ROSSMAN. *Glass Ind.*, **10** [10], 243–45 (1929).—Thirty-seven patents dealing with the manufacture of wire glass, dated from February 1907 to August 1910, are briefly discussed and their chief features are enumerated. For previous abstracts see *Ceram. Abs.*, **8** [9], 640; [10], 721; and [11], 802 (1929). E.J.V.

Alkalinity of Japanese glass. S. KAWADA AND T. SUZUKI. *Jour. Pharm. Soc. Japan*, **49,** 464–75 (1929).—Supplementary note. Cf. Annual Rept. of Kurashiki Central Hospital, Vol. 2, 1928. (*C.A.*)

Economic problems of glass technology. OTAKAR WEBR. *Chem. Listy*, **23,** 146–48 (1929).—A discussion. (*C.A.*)

Use of black glass. ANON. *Nat. Glass Budget*, **45** [23], 5 (1929).—The use of black glass for modern store fronts and interior equipment is developing. This kind of glass has been used extensively in Europe, and is now growing in popularity in the East.

The glass has a high luster polished plate glass finish on one side and is rough on the other side. It is fastened either with cement or by having holes drilled and screwed to the framework. E.P.R.

Glass research during 1928. WERNER MYLIUS. *Sprechsaal*, **62** [37], 677–80; [38], 696–99 (1929).—A bibliography of all domestic and foreign research work pertaining to glass during 1928 together with a brief review of each publication. T.W.G.

Glass Tour, 1928. ALEXANDER SILVERMAN. *Bull. Amer. Ceram. Soc.*, **8** [10], 303–12 (1929).—Not only does S. give a brief résumé of the glass men's tour in connection with the American Ceramic Tour in Europe, but he also describes the interesting points he visited after the main party had left. S. revisited several of the countries covered during the tour but stopped at plants and spots not included in the original trip itinerary. E.J.V.

Value of style and design in selling ceramics. B. MIFFLIN HOOD. *Clay-Worker*, **92** [3], 216–17 (1929); for abstract see *Ceram. Abs.*, **8** [7], 475 (1929). E.J.V.

Knox-O'Neill vacuum bottle machine. R. R. UNDERWOOD. *Glass Ind.*, **10** [10], 251–52 (1929).

Knox O'Neill company expansion plan. ANON. *Amer. Glass Rev.*, **48** [52], 15 (1929); for abstract see *Ceram. Abs.*, **8** [3], 178 (1929). E.J.V.

Fused quartz window panes in world's largest solarium. ANON. *Glass Ind.*, **10** [10], 237 (1929).—An illustrated description of the solarium of the new sanatorium of the Natl. Vaudeville Artists (Saranac Lake, N. Y.) is given. The solarium used 1200 fused quartz window panes made by the General Electric Co. by a process recently developed. The process used in making the fused quartz is briefly outlined. E.J.V.

New skyscraper of glass brick. ANON. *Amer. Glass Rev.*, **49** [2], 27 (1929).—The 65-story Palais de France to be erected in New York will be an example of the use of glass as a major building material. In France and in Germany, particularly, glass brick and other forms of glass, both opaque and translucent, in varied colors and color tones, have taken an important part in the architectural designs submitted for new buildings. The customary glass brick now in use abroad are made in molds and are capable of being erected into a wall in the same manner as common building brick. They are cemented together and formed so as to adhere to each other perfectly. It is claimed that if tests are successful, this glass, which is now produced principally in France, will be used in the manner in which brick, terra cotta, and stone have been used in the past. As used abroad, coloring has been the chief method of producing a decorative effect. It is planned to crystallize a portion of the glass so that in the daytime there will be a more reflective surface for the sun's rays, while at night different effects can be produced by lighting, either from floodlights or from lights placed within the building. E.P.R.

Needs of the theaters for glass EDITORIAL. *Glass Ind.*, **10** [10], 246–47 (1929).—An abstract of "Theater Lighting—Its Tragedies, Its Virtues" by Frank Cambria and Francis M. Falge. They take up the need for color media that will be more durable than gelatin color media now that higher wattages are being used for illumination. The glassmaker's ingenuity is challenged by the situation as it calls for the development of mirrored glass, concentrating reflectors, and colored glass lenses. No such units are on the market. E.J.V.

Glass-covered tower for German weather service. ANON. *Amer. Glass Rev.*, **48** [52], 22 (1929).—German aviation is centered in the glass-covered observation tower of the weather observatory near Berlin. The glass tower, which rests on a turntable so that it may be adjusted to every wind, comes into action every 8 hrs. E.P.R.

Bicheroux plate glass process. J. EARLE FRAZIER. *Bull. Amer. Ceram. Soc.*, **8** [10], 313–14 (1929).—A description of the visit to the plant of the Max Bicheroux &

Co., G.m.b.H., at Herzogenrath, Germany, with a comparison of the old method and the Bicheroux plate glass process now in use at the plant, is given. The operation of the plant is described in some detail. Better quality glass is obtained and there is a considerable saving in the grinding and polishing time. E.J.V.

Belgian glass industry continues active. WILLIAM C. BURDETT. *Commerce Repts.*, **38**, 801 (1929).—The demand for plate glass is satisfactory, the slackening in the American outlet being compensated by orders from other markets. The orders for the better grades of window glass in the Fourcault mills are abundant, though there is a lack of orders among the mouth-blown mills. Another firm, the Verrerie de la Marine, is adopting the Fourcault system. E.J.V.

Consolidation of Belgian glass industry. WILLIAM C. BURDETT. *Commerce Repts.*, **40**, 53 (1929).—The Fourcault factories are now grouped in a cartel and the Mutuelle de l'Industrie du Verre, Société Anonyme, was incorporated at Brussells on May 8, 1929, for the creation, acquisition, development, and exploitation of companies in the manufacture of mechanically drawn glass, by the Fourcault or other processes in Belgium or abroad. E.J.V.

Chilean glass market. ANON. *Glashütte*, **59** [37], 663–64 (1929).—A discussion of the glass industry and its development in Chile and the effect on the foreign market. L.T.B.

BOOKS

Glashütten, ABC, 1929. Dresden; "Die Glashütte;" reviewed in *Pottery Gaz.*, **54** [628], 1620 (1929).—A useful pocketbook containing much information for the technical man in the glass trade. The greater part of the book, aside from the diary, giving atomic weights of the elements, formulas for various compounds, information on the raw materials of the glass industry, etc., is of permanent value. E.J.V.

A Course in Glassmaking. EMILO DAMOUR. This book is the first part of the course. The following subjects are treated: history of glassmaking, glass and the vitreous state, viscosity, chemical constitution of glasses, study of the constituent elements or compounds, colorizers and decolorizers, colored and opal glasses, quantitative analysis of glasses. Reviewed in *Rev. mat. constr. trav. pub.*, No. 237, pp. 143–44B (1929). A.J.M.

PATENTS

Producing laminated glass. JOSEPH A. REECE. U. S. 1,729,125, Sept. 24, 1929. (1) Method of producing laminated glass, which consists in feeding a plurality of glass sheets and a sheet of nonbrittle plastic material arranged in superimposed relation in a generally horizontal direction, and in uniting all of the sheets during the travel thereof to form a composite sheet. (2) In apparatus for producing laminated glass, the combination with means for feeding a plurality of glass sheets arranged in superimposed relation in a generally horizontal direction, of means for interposing a nonbrittle sheet of material between adjacent sheets of glass during the travel thereof, means for successively applying a skin and then a film to the adjacent surfaces of the glass sheets and sheet of nonbrittle material also during the travel thereof, and means for subjecting the sheets while traveling to pressure to unite them to form a composite sheet.

Producing sheet glass. JAMES C. BLAIR. U. S. 1,729,147, Sept. 24, 1929. In an apparatus for producing sheet glass, a furnace containing a mass of molten glass and having a discharge outlet, a receptacle positioned adjacent the outlet for receiving molten glass therefrom, an inclined member associated with the receptacle, the molten glass being adapted to flow from the receptacle down the member, and means for drawing the glass in sheet form from the lower end of the member.

Sheet-glass leer. ENOCH T. FERNGREN. U. S. 1,729,164, Sept. 24, 1929. A glass

annealing oven including side walls and a ceiling, and insulation arranged upon the ceiling, the insulating effect of the insulation varying transversely of the ceiling.

Mold for forming glassware. CARL W. SCHWENZFEIER. U. S. 1,729,363, Sept. 24, 1929. In combination a body mold, a neck mold having a vertical opening therethrough, and a neck mold thimble loosely mounted in the opening and movable radially at times relative to the neck mold by contact with the body mold.

Glass-melting furnace. NESTOR MAMBOURG. U. S. 1,731,248, Oct. 15, 1929. In a glass furnace, a burner comprising a hollow shield, having spaced inner and outer cylindrical walls which have a longitudinal slot in one side thereof, means for creating a continuous circulation of cooling medium between the inner and outer walls, and a gas-pipe extending longitudinally through the shield, the gas-pipe being spaced from the cylindrical walls and provided with a longitudinal series of openings communicating with the interior of the shield.

Sheet-glass apparatus. LUKE C. MAMBOURG. U. S. 1,731,249, Oct. 15, 1929. In sheet-glass apparatus, a receptacle adapted to contain a mass of molten glass, means for drawing a sheet therefrom, rollers engaging both sides of the sheet at the opposite edges thereof, the rollers being inclined at an angle to the direction of movement of the sheet being drawn, shafts carrying the rollers, a base for supporting the shafts, a bearing member to which the base is pivotally mounted, oppositely directed lugs carried by the bearing member, and adjusting screws passing upwardly through the lugs and bearing against the undersurface of the base.

Drawing and flattening sheet glass. THOMAS C. MCKINLEY. U. S. 1,731,253, Oct. 15, 1929. In the art of drawing continuous sheet glass from a mass of molten glass, the process of successively passing a continuous sheet through drawing means, rolling means, flattening means, and annealing means.

Glass-cutting apparatus. JOHN H. MOLLER. U. S. 1,731,257, Oct. 15, 1929. In combination, sheet-glass cutting apparatus including a cutter adapted to be held in the hand and moved across the sheet to be cut, a guide member removably carried by the cutter, and a straight edge adapted to rest upon the sheet and with which the guide member is adapted to contact and along which it is adapted to slide as the cutter is moved across the glass.

Producing sheet glass. WILLIAM E. NOBBE. U. S. 1,731,260, Oct. 15, 1929. The method of forming sheet glass, which consists in creating two downwardly flowing streams of molten glass, maintaining the body portions of the streams free from contact with mechanical means during the major portion of their travel, uniting the streams and continuing movement thereof in the form of a single sheet.

Cooler support for sheet-glass apparatus. GEORGE M. SNODGRASS. U. S. 1,731,278, Oct. 15, 1929. In sheet-glass apparatus, a heat-absorbing member, means for adjusting the member vertically, means for adjusting the member horizontally, and means for varying the angle of the member relative to the sheet.

Grinding and polishing plate glass. GEORGE E. HOWARD. U. S. 1,731,663, Oct. 15, 1929. The method which comprises increasing the temperature of a plate of glass, polishing the same, shielding the glass from air currents during polishing, and retarding radiation of heat therefrom after completion of the polishing operation.

Feeding molten glass. KARL E. PEILER. U. S. 1,731,681, Oct. 15, 1929. (1) In glass feeding, the method of suspending and shaping a mass of molten glass issuing from a submerged outlet of a container, which comprises regulating normal gravity flow of glass to the outlet and sequestering part of the glass within the container above the outlet, varying the relative fluid pressures on the sequestered glass and the remainder of the glass within the container to further regulate flow through the outlet and to aid in suspending and shaping the issued glass, and further aiding in suspending and shap-

ing the issued glass by disposing a rigid implement in position to depend through the sequestered glass into the outlet without completely obstructing the outlet. (2) The method of feeding molten glass in mold charges, which comprises flowing glass by gravity downwardly through a submerged outlet of a glass container, periodically accelerating and retarding flow of glass through the outlet by reciprocating an implement in adhesive contact with the glass substantially in line with the outlet, further accelerating and retarding flow of glass through the outlet by imparting, expelling, and retarding fluid impulses to the glass surrounding the implement above the outlet in timed relation to the accelerating and retarding strokes of the implement, and periodically severing mold charges from successive masses of issued glass in timed relation to the application of the expelling fluid impulses and while such masses are suspended below the outlet.

Cutting laminated glass. SAMUEL J. LEWIS. U. S. 1,731,820, Oct. 15, 1929. Process of cutting laminated glass consisting in scoring the two outer laminations of the sheet, separating each of the outer laminations, then relatively moving the two pieces of at least one of the outer laminations a distance sufficient to allow the insertion of a severing means and then severing the inner lamination.

Glass feeder. LEONARD D. SOUBIER. U. S. 1,731,947, Oct. 15, 1929. (1) In a glass feeder, a container for a supply body of molten glass formed with a bottom outlet opening, a continuously rotating glass stirring implement projecting into the glass over the outlet opening and formed with a downwardly opening chamber, a pair of diaphragms communicating with the chamber, and means to operate the diaphragms one at a time to alternately apply air pressure and vacuum to glass in the chamber whereby issue of glass through the bottom outlet opening is alternately accelerated and retarded. (2) In glass-feeding apparatus, the combination of a glass tank, a forehearth extending therefrom and provided with a discharge outlet through which molten glass issues, means including a vertically movable gate dividing the forehearth into front and rear compartments, the front compartment having a bottom outlet through which molten glass is discharged, means for directing a heating flame into the front compartment, means including a port above and separate from the gate for directing the spent gases of combustion into the rear compartment and discharging them therefrom to the outside air, and a gate for controlling the passage of the gases through the port.

Making composite glass. WILLIAM O. LYTLE. (1) U. S. 1,732,022, Oct. 15, 1929. In combination in apparatus for use in securing together a set of sheets of similar size arranged in a pile with their edges flush to form a plate of composite glass, a shielding strip of relatively hard material extending around the edges of the sheets and lying over the joinder between the sheets, a strip of flexible material of general U-shape fitting over the shielding strip with its edges in engagement with the outer faces of the outer sheets, a pressure chamber surrounding the sheet thus assembled, and means for successively applying suction and fluid pressure to the chamber. (2) U. S. 1,732,023, Oct. 15, 1929. In apparatus for securing together a set of sheets, a tray having a flat rigid bottom adapted to receive the set of sheets, a removable flexible sheet closing the top of the tray and making sealing contact with the edges thereof, means for exhausting the air from the interior of the tray to bring the edges of the sheet into sealing contact with the edges of the tray and to cause the pressure of the atmosphere on the flexible sheet to clamp the series of sheets tightly against the flat rigid bottom of the tray, and a pressure chamber for receiving the tray, with means for applying fluid pressure thereto on all sides of the tray and its closure.

Apparatus for rolling glass. JOHN H. FOX. U. S. 1,732,042, Oct. 15, 1929. The combination with a glass casting roll, of a sizing roll thereabove comprising a cylindrical casing, a glass engaging jacket mounted on the casing consisting of a series of collars

placed end to end and each having a loose fit on the casing, and means for holding the collars so that their interior surfaces are out of contact with the periphery of the casing along the portion thereof most remote from the periphery of the casting roll.

Glass blowing. UNITED GLASS BOTTLE MANUFACTURERS, LTD., AND T. C. MOORSHEAD. Brit. 316,086, Sept. 18, 1929. Relates to a revolving press and blow machine of the kind in which a registering head is provided for accurately registering a ring mold with a parison mold or a finishing mold. For previous abstract see *Ceram. Abs.*, **7** [4], 230 (1929).

Glass annealing. PILKINGTON BROS., LTD. Brit. 316,354, Sept. 18, 1929. Relates to the method of making plate or sheet glass in which glass strips, produced intermittently, are received on a roller conveyer by which they are carried to, and through a leer, and means are provided for reducing the speed of the rollers, after the glass has set, in order that the leer may be of reasonable length.

Antidazzle glasses. C. G. BOSTRÖM. Brit. 316,448, Sept. 18, 1929. A protective glass for spectacles having an intermediate color wedge between outer glasses is constructed with the color wedge embedded within an uncolored layer of uniform thickness of resin compounds, which layer has the same refractive index as the outer glasses. The glass may be made by applying a resin compound layer to one glass and then placing the color wedge upon the resin layer. Upon this is placed a further resin compound layer and a second cover glass, the resin compound uniting the whole into a single unit.

Glassmaking. CHANCE BROS. & CO., LTD., AND C. E. GOULD. Brit. 316,464, Sept. 18, 1929. A glass suitable for protecting pictures, fabrics, or other objects from deterioration when exposed to daylight, absorbs radiation of shorter wave-length than about 3800 A.V. while transmitting at least 70% of normally incident daylight. The glass is made by adding small quantities of any convenient chromium compound and of vanadium oxide to the ordinary batch for producing clear window glass.

Compound transparent sheets. D. G. CARR AND C. J. CARR. Brit. 316,496, Sept. 18, 1929. Compound transparent sheets of glass and celluloid are formed by coating the inner surfaces of the glass sheets which are preferably roughened with caoutchouc mastic and applying to this when dry, suitable adhesive such as celluoid solution; the coated glass and the celluloid are then treated with a suitable solvent and united by heat and pressure; the surfaces after applying the solvent may be allowed to dry and after treatment with a nonoxidizable vegetable oil are united by heat and pressure.

Delivering molten metal. H. WADE. (1) Brit. 316,837, Sept. 25, 1929. Relates to a feeder of the reciprocating-plunger type and consists in using a single driving-device for reciprocating the plunger and operating the shears, and in providing means for varying the stroke of the plunger, and its position in respect to the discharge outlet, independently of the operation of the shearing mechanism. (2) Brit. 316,838, Sept. 25, 1929. A feeder of the reciprocating-plunger type is provided with means for bringing the plunger nearer to one side of the outlet, usually the side toward the tank, in order to compensate for the effect of variations in the temperature of the glass around the outlet. A device is also provided for indicating to the machine minder the spacing between the internal wall of the outlet and the lower end of the plunger.

Glass rolling. SCHLESICHE SPIEGELGLAS-MANUFACTUR C. TIELSCH GES. Brit. 316,968, Oct. 2, 1929. Process for making wire glass of the kind in which the reinforcing wires are parallel with one another, consists in forming two sheets of glass by means of a duplex double-roll machine, rolling the two sheets together to form a single sheet, and feeding the wires between the two sheets just before they are united with one another.

Delivering molten metal. T. F. PEARSON. Brit. 316,926, Oct. 2, 1929. A feeder has a number of movable gates or plugs arranged across the forehearth for regulating the flow of glass along the sides of the forehearth and the flow of hot gas at the center.

Drawing glass. Soc. Anon. des Ateliers de Construction et Fonderies de Jeumont, Anciens Établissements T. Haut. Brit. 317,067, Oct. 2, 1929. Relates to a sheet-drawing apparatus, in which the glass sheet is drawn vertically upward between pairs of opposed rollers; provision is made for one roller of each pair to yield to irregularities in the glass sheet. According to the invention, the movable roller is journaled in, and suspended by counter-weighted bell-crank levers which permit the roller to yield more readily than those described in the parent Specification.

Compound transparent sheets. G. E. Heyl. Brit. 317,240, Oct. 2, 1929. Means are provided for preventing the formation of air bubbles between the glass and cellulose derivative sheets when joining them by direct fluid pressure, to form compound transparent sheets. The sheets preferably separated by corrugated spacers of zinc or celluloid are immersed in the solvent or adhesive in the bag in which they are subsequently pressed and after closing the bag it is exhausted to a pressure of about 4 in. of mercury through a tank and air pump. Residual solvent is then drained away for about 30 min. and the bag subjected for 15 min. to steam pressure which is increased to 35 lbs. in an autoclave, one or both wooden sides of the crate having been removed. Rubber mats are inserted as packing when the spacers have been removed. The immersion of the sheets is preferably effected by pouring the solvent in at the bottom of the bag. The bottom of the frame on which the bag is distended is ribbed to engage the edges of the glass sheets.

Compound glass. "Mühlig-Union" Glashütten A.-G. Austrian 111,832, Aug. 15, 1928. Celluloid sheets are coated or rubbed on both sides with a fatty or waxy substance, *e.g.*, a glyceryl ester of a lower fatty acid or a lower alkyl ester of a higher fatty acid, which penetrates but slowly into the celluloid and hinders absorption ofsolvent. A solvent is then applied and the sheets are united with glass sheets by pressure. (*C.A.*)

Working glass and similar substances. J. Viatour. Belg. 355,730, Dec. 31, 1928. The flame is obtained by means of a gaseous hydrocarbon of high calorific value (except CH_4), preferably a mixture of C_2H_2 and O_2. (*C.A.*)

Glassmaking. Naamlooze Vennootschap Mij. tot Beheer en Exploit. van Octrooien. Fr. 645,995, Dec. 21, 1927. Means for transporting the sheets to and through the coolers are described. *Ibid.* Fr. 657,627, July 18, 1928. Method of transporting sheets to the cooling furnace. See preceding abstract. (*C.A.*)

Electric furnace for glassmaking. Henri George. Fr. 655,751, Oct. 25, 1927. (*C.A.*)

Glassmaking. Soc. Anon. des Manufactures des Glaces et Produits Chimiques de Saint-Gobain, Chauny et Cirey. Fr. 658,192, Dec. 8, 1927. Method of arresting the flow of glass from the furnace. (*C.A.*)

Drawing hollow-glass bodies from the molten mass. Leonhard Bock. Ger. 478,583, Feb. 20, 1926. (*C.A.*)

Drum for glass working. Soc. Anon. des Ateliers de Construction et Fonderies de Jeumont, Anciens Établissements T. Haut. Ger. 478,888, April 20, 1926. (*C.A.*)

Heavy Clay Products

Scum and efflorescence. Ellis Lovejoy. *Clay-Worker*, **92** [3], 205–208 (1929).—The definitions of scumming and efflorescence given by F. G. Jackson are cited (*Bull. Amer. Ceram. Soc.*, **4** [8], 376–401 (1925)). The cause of scum in clayware is explained, the chief compound that offends being sulphate of lime, as it is the one mineral which does not decompose or combine with the clay at or below the hardening temperature of the clay. If the ware is fired at a higher temperature than the burning-in temperature of lime sulphate, even the scum caused thereby will disappear. Scum is caused

by soluble salts in the clay and pugging water, or by soluble salts developed by sulphur acids in the process of drying and firing. The scum developed due to soluble salts in the clay and pugging water can be overcome by the addition of barium carbonate. The scum developed from the acid fumes in the drier and kiln can be prevented only by the elimination of the sulphur gases from the drier by fully drying the ware before placing it in the kiln (if coal fired), by careful firing to avoid excessive evaporation and subsequent condensations, and by having strong draft and free floor passage for the escape of the water vapor from the kiln floor. Reducing conditions do not prevent the development of the scum, but greatly aid in decomposing it and burning it in. Efflorescence is the builder's and architect's problem since it is the coating which comes out to the wall surface. The coating is soluble and generally consists of the sulphates of the alkalis, magnesium, and lime, the first two mentioned predominating. Reducing kiln conditions will be effective in breaking up and combining the sulphates in the mass of the ware, and this, together with hard firing, is the effective method of overcoming subsequent efflorescence. Efflorescence on walls is more often due to other materials than fired clay ware, yet the clay product gets the blame because the efflorescence stands out on the face of this ware. The mortar, cast and natural stone trimmings, and concrete are largely to blame. The use of ammonium or calcium stearate, or barium carbonate in the mortar aids in precipitating the sulphates or repelling the water so that the salts cannot be carried into the clayware wall. Some exception is taken to Palmer's division of scum into two distinct types, differing chemically, physically, and in their origin. An attempt to reconcile his distinctions with experience and wide observation leads to several inconsistencies. With certain exceptions cited Palmer's work is agreed with. E.J.V.

Efflorescence in brickwork. W. A. WRIGHT. *Claycraft*, **1**, 300–305(1928); *Bldg. Sci. Abs.* [N.S.], **1**, 236; for abstract see *Ceram. Abs.*, **8** [8], 579 (1929). (*C.A.*)

Causes and cures of scum. ANON. *Brit. Clayworker*, **38** [449], 194–96 (1929).—This problem is complex because of the fact that there are several kinds of scum each due to a different cause. Soluble salts in the clay may be regarded as the first cause of scum. These salts may be either the nitrates, chlorides, or sulphates of potassium, sodium, calcium, and magnesium. The largest part of soluble salts are sulphates, and although in most cases the salts present are less than 1%, they are drawn to the surface during drying and are greatly concentrated. The addition of barium carbonate is customarily made to convert the soluble salts into insoluble barium sulphates. Many clayworkers add too much of this salt to secure a satisfactory result. It is preferable to add it as a milk to insure uniform distribution in the clay mass and ample time should be allowed for it to react. Weathering a clay will sometimes cause formation of scum. Ashes, gypsum, and lime compounds may all be causes of scum in brick. Kiln white, storage scum, and wall white are described and their formation is discussed. The following hints summarize the conditions essential to the prevention of scum: (*a*) avoidance of clay containing much sulphate or pyrites; (*b*) avoidance of clay rich in limestone or its equivalent; (*c*) use of coal containing less than 1% sulphur; (*d*) heating the freshly set goods with clean warm air until they are so hot that no condensation can occur on them; (*e*) freshly set goods must be allowed to come in contact with kiln gases; (*f*) neither during storage nor use should the goods come in contact with materials which contain soluble salts. R.A.H.

Absorption of water by brick. ANON. *Rev. mat. constr. trav. pub.*, No. 239, p. 172B (1929).—A mathematical treatment of absorption is given. A.J.M.

Scientific research on bricklaying begun at Mellon Institute. ANON. *Brick Clay Rec.*, **75** [8], 479–80 (1929).—An interesting example of collaboration between scientist and artisan is found in the broad scientific study of bricklaying recently inaugurated

by the Mellon Institute and the Eastern Face Brick Mfrs.' Assn. under the direction of F. O. Anderegg and his assistants. Architects, building contractors, and masons are aiding the work by contributing opinions and advice based upon experience. Some 300 experimental walls or panels have been erected. The investigation will cover certain aspects of all the factors involved in bricklaying. The most obvious points of attack are studies of the characteristics of different kinds of brick and mortar. Problems of special appeal to the practical man are those concerned with different methods of backing and with differences in workmanship. The design of walls and their relative elasticity are subjects which will be of importance to contractors and architects. A detailed account of some of the specific problems under investigation is given.

E.J.V.

Tests show interlocking-rib tile gives greater wall strength. ANON. *Brick Clay Rec.*, **75** [7], 414–15 (1929).—In an attempt to obtain a building unit which will give walls greater transverse strength than is obtained now with the tile available, Luther S. Manson has developed an interlocking-rib tile, which according to tests is said to give walls considerably higher transverse strength and at least as high a compressive strength as similar walls built of tile of the usual design. The chief feature of this tile is the ribs which project from one face. These are designed to be set vertically near the mid-plane or walls, with the ribs of adjacent tile interlocking so as to effect a mechanical bond between the units. These spaces between the outside ribs of the adjacent tile are grouted after the tile are set in place. Results of tests are given.

E.J.V.

Compressive strength of clay brick walls. ANON. Bur. Stand., *Tech. News Bull.*, No. 149, pp. 89–90 (1929).—The results of an investigation of the compressive strength of brick walls are given.

R.A.H.

Salt glazing ceramic products. J. OTIS EVERHART. *Brick Clay Rec.*, **75** [8], 480 (1929).—The principle of the old salt-glazing method and its applications is discussed. In the new method developed for use in other than downdraft kilns, to which the old method was limited, a clay slip made from the same material as the body is used as a medium for introducing the salt. It has the advantage of giving a uniform coating of salts, contains all the necessary elements for glaze formation, and covers surface imperfections. A concentration of salt of about 35% in a slip of about 1:3 specific gravity has been found to be satisfactory. Fine grinding of both slip and salt produces a smoother surface, and spraying seems to be better than dipping as a mode of application.

E.J.V.

Handling wet, stony clays. I. ANON. *Clay-Worker*, **92** [3], 209–11 (1929).—In order to remove limestone pebbles, it was necessary to remove the moisture and to pulverize and screen the clay. The clay was dug with a clay digger with the advantages of giving a thorough mixture of clay regulation so as to cut very thin layers of clay making it easier to dry, and the exposed bank permitting the sun to dry some of the moisture. The clay was dried in a rotary drier and then pulverized with a ring-hammer pulverizer. The greater the per cent of lime the finer the clay must be ground. Two screens were used, the top 8-mesh and the bottom 40-mesh. Storing and aging this clay gave the advantages of removal of toughness, increased capacity in molding, less power, reduction of drying and firing time and of drying and firing loss, and quality of finished ware improved. The method of operation used at the plant of the Emaus Brick Co. (Emaus, Pa.), using a pebbly clay is described in some detail.

E.J.V.

Crating of hollow ware. REDING PUTNAM. *Brick Clay Rec.*, **75** [7], 422 (1929).—The systematic plan of crating, bracing, and shipping each year more than 2000 carloads of hollow tile products ranging from small drain pipe to large sewer tile with a

minimum of loss and breakage is discussed. Certain basic points that must be used as a starting point in all considerations of loading and bracing clay products are enumerated. E.J.V.

Use of salvaged brick. EDGAR R. WAGNER. *Brick Clay Rec.*, **75** [7], 423 (1929).—In using salvaged brick for exterior construction in order to give an aged appearance, there is danger of having mixed in soft brick which crumble under weathering. Another danger lies in the possibility of the used brick having been coated at some time or other during its life with grease, tar, or some waterproofing compound which will cause serious disfigurement in the outside walls. A report on a problem brought about by the use of salvaged brick is included. E.J.V.

Automatic cutting tables. III. ANON. *Brit. Clayworker*, **37** [442], 423–24 (1929).—The Keller full automatic, a cutting table developed in Sweden by Abjörn Anderson, and the Frey cutting table are briefly described. The Keller table has the unique function of delivering spaced brick on a traveling pallet which is subsequently handled by the automatic loader to the humidity drier. The Swedish machine requires a column rather softer in character than usually made; it is ingenious in design. The Frey table is to be preferred for tile production or for hollow brick. The cut is vertically downward. For Part II see *Ceram. Abs.*, **8** [9], 670 (1929). R.A.H.

Brick in open masonry. ANON. *Tonind.-Ztg.*, **53** [30], 577–78 (1929).—Methods of laying various kinds of brick in the building of thick walls with the use of a minimum quantity of brick are described. The various types of hollow tile in use in Germany are also described and illustrated. The following types of masonry are discussed: (1) walls of perforated brick, (2) walls of hollow tile, (3) "Aristos" tile in 3 styles, (4) "Schima" tile in 3 styles, (5) "Frisklock" tile, (6) the Eckert wall, (7) the Tauber wall, (8) the Katona wall, (9) the Fauth wall, (10) the Weltstein hollow tile, and (11) the Schönfelder angle tile. F.P.H.

Brick veneer construction. ALLEN R. SMITH. *Bldg. Age*, **51** [9], 80–81 (1929).—The proper construction is stated to be as follows: brick veneer, air space, building paper, sheathing, studding, lath, and plaster. The cost of a veneered home built in Iowa is given. T.W.G.

Paving brick in Illinois. ANON. *Brick Clay Rec.*, **75** [8], 474–76 (1929); *Clay-Worker*, **92** [3], 197–201 (1929).—One of the most constructive efforts to be made in the interest of the clay products industry is a movement begun by the Poston-Springfield Brick Co. (Springfield, Ill.), and backed by the entire Illinois clay products industry, to put paving brick back on the highways of the state of Illinois. If this proposition is successful it will revive the paving-brick industry in that state and will divert an enormous production now in the building brick industry back to its rightful place in the paving-brick industry. The idea is to resurface with brick the many hundreds of miles of concrete roads that have been built in the state in recent years and which are now rapidly going to pieces. E.J.V.

Use of face brick in Chicago. ANON. *Brick Clay Rec.*, **75** [7], 410–12 (1929).—Some of the reasons for the discouraging drop in face brick sales are enumerated and some ways of improving the situation are suggested. E.J.V.

Belgian brick industry. FRANCIS H. STYLES. *Commerce Repts.*, **41**, 98–99 (1929).—The production of bricks in Belgium is primarily seasonal. The winter months, particularly, February to April, are usually utilized for the air-drying operation, and many kilns close rather than be on a part-time schedule. Cold weather affects transportation by canals, on which the majority of the brick factories are located. Exports of common brick to the U.S. in 1927 amounted to 78,180 thousand; in 1928, 61,386 thousand; and for the first seven months of the current year, 10,511 thousand, showing a steady decrease. Present price quotations are largely governed by demand with

manufacturers setting their own prices. Certain shipments are stated to have been made to the U.S. at $4.30 f.o.b. plant. E.J.V.

Hollow block in Germany. ANON. *Brit. Clayworker*, **38** [449], 197–99 (1929).—More than 40 firms in Germany are now producing the so-called "one-hand" double block and their ready sale has proved that they are preferred to ordinary brick. The advantage of using this block together with a description of the method of manufacture is given. R.A.H.

BOOK

Testing of Road-Building Materials. ROGNAR SCHLYTER. Published by *Tonind.-Ztg.*, Berlin; reviewed in *Rev. mat. constr. trav. pub.*, No. 231, p. 287B (1928). A.J.M.

PATENTS

Pointing brickwork. C. J. BARBER. Brit. 316,737, Sept. 25, 1929. A brickwork pointing appliance comprises a rotary scraper for cleaning out the rough mortar, a water jet for wetting the scraped part, a valve controlled mortar delivery nozzle and a smoothing shoe adjacent the latter. The scraper is in the form of a toothed wheel mounted in a bracket and rotated through gearing by hand-driven means or by a flexible shaft and small motor. The water jet is located between the scraper and the mortar nozzle on the end of a supply pipe fitted with control valve, the smoothing shoe being adjacent the nozzle.

Ceramic and roofing tile. ERNEST A. ETHERIDGE. Australia 12,342, Mar. 19, 1928. Tile having a low weight and a glazed surface are made by mixing white cement with an aggregate of siliceous clay, aluminous clay, Cornish stone and (or) feldspar and with or without pulverized slate or pumice; and a glaze is applied consisting of a slip prepared from the same ingredients together with a frit in very finely powdered condition with ZnO, barytes, SnO, or $Al(OH)_3$. For fired goods, fusible clay, pulverized pumice, and siliceous sharp sand, and (or) magnesite are mixed with any fusible frit and glaze is applied thereto. (*C.A.*)

Refractories

Cone-fusion muffle furnace for high temperature work. HENRY N. BAUMANN, JR. *Jour. Amer. Ceram. Soc.*, **12** [11], 740–41 (1929).—A laboratory type muffle furnace in which the muffle (inside dimensions 9 by 6 in.) was built of standard "Refrax" brick and heated by means of two slotted graphite electric resistors, has been in use for over a year in the Research Laboratory of The Carborundum Company at Niagara Falls. Although specifically designed for cone fusion studies, in which work it is very successful, it can be used for other laboratory work especially at high temperatures (up to at least 1600°C) such as small fusions, heat treatment, etc.

Transverse breaking strength of refractories. CEDRIC A. VINCENT-DAVISS. *Jour. Amer. Ceram. Soc.*, **12** [11], 738–39 (1929).—A furnace has been designed which has the following characteristics: (1) The possibility of running a 24-hr. day testing schedule. (2) The feasibility of measuring the modulus of rupture at temperatures up to 1500°C.

Modern water-cooled refractory furnaces. C. H. S. TUPHOLME. *Mech. World*, **86** [2228], 247 (1929).—The capacity of a furnace is measured in B.t.u. released per cubic foot of furnace volume. By using water-cooling tubes in the walls, reducing their temperatures just sufficiently to insure durability and convenient handling of the ash all the advantages of a hot furnace were easily maintained, and the disadvantages of the cold furnace were avoided. From the point of view of durability, the water-cooled refractory furnace makes for moderation, in that the refractory is prevented from reach-

ing a destructive temperature by the cooling effect of the tubes, and the tubes are shielded from the intense radiant heat of the flame by the refractory. E.P.R.

Insulation of coke-ovens and blast-furnace stoves with sterchamol. A. KILLING AND K. THEIS. *Glückauf*, **64**, 1482–87 (1928); *Stahl Eisen*, **49**, 65–72 (1929).—In the construction of new coke-oven batteries and blast-furnace stoves or in reconstructing old ones it has become the general practice to insulate them to reduce the heat losses. The material used (in Germany) is almost without exception sterchamol, a natural infusorial earth occurring in Denmark, which can be pressed into brick of varying porosity, and these when fired have a crushing strength of 170 to 1700 lbs. per sq. in. Comparative temperature measurements made on the outside of heat-insulated coke ovens, regenerators, and stoves and on uninsulated plants are recorded. (*J.I.M.*)

Constructional materials and insulation of electric furnaces. K. VON KERPELY. *Metallbörse*, **18**, 2021–22, 2077–78, 2302–2304, 2469–70 (1928).—A review of modern methods of constructing electric furnaces and of the suitability of various refractories for different work, with special reference to steel manufacture. (*J.I.M.*)

Progress in electric furnaces for nonferrous metals. M. TAMA. *Engineering*, **128** [3323], 389–91 (1929).—Some of the latest developments in melting and annealing furnaces for metallurgical purposes are described. Electric-arc furnaces and indirect-resistance furnaces are giving way to the induction furnace for the treatment of nonferrous metals. The use of the latter type of furnace is extended for melting alloys with a high percentage of copper or even nickel by the use of the Rohn method which consists in replacing the ramming of the refractory lining in combination with a liquid binding substance, by fritting it from dry granular refractory material in a metallic mold within the furnace. The most recent linings have lasted six months, working continuously day and night. In making this lining, quartzite, as pure as possible, is used together with specially prepared dry binding substances. Some recently built furnaces are illustrated. A.A.

Refractories service conditions in furnaces burning fuel oil. R. A. SHERMAN, E. TAYLOR, AND H. S. KARCH. *Fuels and Steam Power* (*A.S.M.E. Trans.*), **50** [23], 313–22 (1928).—A progress report of committee on boiler-furnace refractories. Slag formed in furnaces was the result of fusion of oil ash. Slag action was probably related to spalling. (*C.A.*)

Proprietary air-cooled refractory (furnace) walls. C. S. GLADDEN. *Trans. Amer. Soc. Mech. Eng.* (Advance Paper), 11 pp., [May 13–16] (1929). (*C. A.*).

Reducing furnace refractory costs. J. L. GRAUEL. *Ind. Power*, **16** [6] 67–68, 122–28 (1929).—Installation of SiC refractory furnace linings increased life of the bridge wall at a large paper mill 4 times. By air-cooling the wall, preheated air was furnished for combustion, bringing about further saving in fuel. (*C.A.*)

Improvement of refractory lining of heat-treating furnaces for high temperature annealing of steel castings. WILLIAM J. MERTEN. *Trans. Amer. Soc. Steel Treating*, **16** [4], 600–606 (1929).—The employment of high temperatures for refinement and adjustment of grain structure of large-section steel castings compels the consideration of a furnace lining of greater refractory characteristics than is usually used in steel foundry annealing equipment. Ordinary fire brick or silica brick bonded with fire clay devitrifies around 1900°F and is not satisfactory for intermittent exposures at 2000°F because of rapid deterioration. Spray coating of a refractory glaze is suggested. A survey of refractory glazes used in the high voltage porcelain industry offered a solution to the problem. "Albany Slip" is sprayed over and into the brick sidewalls and cover of the furnace. Glazing takes place at about 2000°F. Cooling results in rupture of the glaze into fine fissures on the surface which heal up again on subsequent heating. The continuous reheating and reglazing brings about a lowering of the glaz-

ing temperature due to enriching in silica content which is beneficial up to a certain point. When this point is reached it is advisable to respray. The benefits derived from glazing of the furnace chamber walls are (1) saving in fuel cost, (2) more uniform heat distribution, (3) less scaling, (4) easier checking of furnace temperatures, and (5) economy from reduction of cost of maintenance of linings. The coating of steel surfaces for protection against scaling at high heat is usually defeated by peeling or spalling of the coating upon drying and by lack of bonding material. The use of soapstone or talc in a finely divided condition preliminarily applied, solves this difficulty. The cost of materials and labor for this work is small. E.P.R.

Refractories for the cupola. C. E. BALES. *Trans. Amer. Foundrymen's Assn.*, **36,** 683–96 (1928).—A general description is given of the various processes for the production of cupola blocks. Their properties and behavior in use are also discussed. (*J.I.M.*)

Refractory brick and linings of chromite. ANON. *Tonind.-Ztg.*, **52,** 1608–1609 (1928).—In making refractory chromite articles the washed and powdered mineral is bonded with fire clay and aluminum hydroxide, together with a proportion of an organic binder such as starch, coal, etc. On firing at a high temperature a small quantity of the mineral is reduced to ferrochromium, which increases the hardness, crushing strength, and resistance to abrasion. The addition of a little chromic acid to the binder improves the properties of the brick. Another good binder for chromite is gypsum, the lime content of which forms calcium chromite around the chromite particles, thus giving a strong brick. (*J.I.M.*)

Refractory linings. C. P. F. WAIDLER. *Fuel Oil*, No. 8, pp. 25–26 (1929); *Refrac. Jour.*, **4** [48], 399 (1929); see *Ceram. Abs.*, **8** [9], 660 (1929). E.P.R.

Plastic linings for cupolas. G. H. ZIRKER. *Die Giesserei*, **15,** 1145–49 (1928); *Foundry Trade Jour.*, **41** [682], 194–96 (1929).—This is an account of an investigation of the durability of a plastic instead of brick lining for cupolas. The composition of the plastic lining is: 85 to 95% silica, 5 to 15% alumina, and 1 to 2% lime, magnesia, the alkalis, and occasional traces of ferric oxide and titanic acid. It is stated that about 60% of the German foundries are using rammed-out plastic linings. German cupola practice is discussed with respect to the use of a plastic lining. Details for ramming the lining are given with a description of the tools to be used. Instructions for drying the lining are given with some information concerning repairing. The article contains a table of results obtained from industrial cupolas using a plastic lining. O.E.M.

Ladle linings for brass foundries. ANON. *Brass World*, **25** [9], 213 (1929).—Experiments conducted by the Quigley Furnace Specialties Company (New York City) in the use of high temperature cements for ladle linings are reported. A large number of cements were selected and preliminary tests were made in a small way to determine their merit. Actual practice tests were made on three products in lining 300-lb. ladles used in the brass foundry. The method of lining was tried out with three selected refractories, designated as refractories *A*, *X*, and *Y*. The mixture used in refractory *A* was $^2/_3$ crushed fire brick and $^1/_3$ "Hytempite," manufactured by the Quigley Co. As a result of these tests, the company has standardized on refractory *A* for ladle linings in its brass foundry. E.P.R.

Cupola linings. L. SCHMID. *Z. ges. Giessereipraxis*, **50,** 161–64, 197–99 (1929).—Properties of refractory materials suitable for cupola linings (fireclay brick, quartz brick, magnesite or dolomite brick) are discussed. (*C.A.*)

A laboratory slagging test for boiler-furnace refractories. R. K. HURSH. *Trans. Amer. Soc. Mech. Eng.* (Advance Paper) 6 pp. [May 13–16] (1929).—Particulars of simulative service test of refractories with coal-ash slag made in a laboratory furnace in which test brick form the lining of a cylindrical chamber rotated about a vertical axis. Tests

have been made with slags representing coals used at five power stations where field tests were conducted. (*C.A.*)

Boiler-furnace refractories. C. F. HIRSFIELD AND W. A. CARTER. *Fuels and Steam Power* (*A.S.M.E. Trans.*), **50** [23], 115–25 (1928).—Brick, tile, wall mortars, plastic compounds, and so-called high-temperature cements were studied. A field survey of conditions to which refractories were subjected in different kinds of service was made along with the laboratory investigation to determine the chemical and physical phenomena occurring in boiler-furnace refractories. (*C.A.*)

Working life of retort settings. R. L. GREAVES. *Refrac. Jour.*, **4** [48], 369–70 (1929).—The working life of a retort setting depends on (1) the materials used; (2) the design, foundations, and building of the setting; (3) the starting-up process; and (4) the working methods and conditions. For long life, fire clay and silica materials must (1) possess refractoriness, and resist any temperature they are likely to meet, (2) resist rapid fluctuations in temperature, (3) withstand working loads and strains at working temperatures, (4) resist chemical action of dust or atmosphere, and (5) expansion or shrinkage on firing should be small. These requirements apply equally to jointing material. Porosity increases resistance to temperature fluctuations, but reduces the strength of a material and increases liability to chemical attack. The more nearly jointing material approaches in chemical composition and physical behavior to that of the brick with which it is used, the more satisfactory are the results obtained. As an example of a reasonable working life for silica segmentals, figures (recently published) referring to Beckton stated that a life of 2000 days was hoped for, with the carbonization of 3400 T. per 20 ft. retort, and 4000 T. per 23 ft. retort. E.P.R.

Jointing cements. CYRIL EDWARDS. *Refrac. Jour.*, **4** [48], 371–78 (1929).—Jointing cements are those materials used for bonding or uniting brick designed for use at temperatures considerably above the normal. Jointing cements used at comparatively low temperatures are "pointing," "patching," or "fire" cements. E. deals exclusively with cements for silica and fire brick. The properties necessary and desirable are as follows: (1) *Working qualities:* Without an adequate degree of plasticity, it is impossible to obtain either thin or well-filled joints, as the rate of drying is too rapid. (2) *Grain size and texture:* Joints not thicker than $^1/_8$ in. are desirable; therefore, jointing cements should have practically no particles larger than $^1/_{25}$ in. and should pass a 40-mesh cement sieve. Excessive fineness is not necessary, and if a cement passes completely a 20-mesh sieve and has at the same time some 45 to 50% of material passing a 200-mesh sieve, it meets with approval in regard to grain size. (3) *Shrinkage:* Cements which showed anything from 0 to 2% linear contraction on drying and with an after-expansion of 1 to 1.5% dry to fired, have been successfully employed. (4) *Adherence to brick:* Cements adhere well to ordinary fire brick, but with more difficulty to silica brick due to transformations occurring between 100°C and 300°C, at about 575° C and above 1400°C. Cements containing much converted quartz (*e.g.*, silica brick itself) adhere better to silica brick than do those composed mostly of raw ganister or quartzite. (5) *Hardness after drying and when fired:* Finely-ground glass is sometimes introduced into cements to give hardness. (6) *Strength:* The fineness and shape of the particles, whether angular or round, and the presence of low-temperature fluxes all influence this property. A refractory cement for use up to 1500°C should have a cold tensile strength of at least 80 lbs. per sq. in., after a firing at 1300°C for 2 hrs. (7) *Refractoriness:* Refractoriness of a cement should be equal to that of the brick. In cements composed of silica rock bonded with lime, the refractoriness may be increased by a reduction in the grain size. The addition of sodium silicate is not always a serious detriment to refractoriness. Among the large variety of raw materials which have been used in compounding jointing cements, the most important are silica rock (includ-

ing sand, ganister, and quartzite), silica brick, raw fire clay and fireclay grog (from either fired clay or waste brick). The principal bonding agents are ball clay, lime, Portland cement, sodium silicate, and ground glass. Silicon carbide, asbestos, chromite, and barium sulphate are often used in the preparation of various mixtures. The presence of ground fire clay in a cement is very desirable from the point of view of giving plasticity, but its use in excessive proportions tends to produce high shrinkage with the development of cracks on drying and on firing. Fired fireclay grog, although more expensive, is generally preferable to ground firebrick grog, as it disintegrates into particles more angular in shape, and thus bonds better. Specifications and testing methods are given. E.P.R.

Durability of rammed and jolted converter bottoms. H. WEISS AND P. RÖLLER. *Stahl Eisen*, **48**, 1737–42 (1928).—Trials at Völklingen have shown that the average life of a rammed dolomite converter bottom, 28 in. thick and about 65 in. diam., was 38.3 charges. The jolting method was adopted for making these bottoms and a jolting machine was installed, which is illustrated and described in the article. The jolted bottom takes one-quarter the time to make compared with that required for making a stamped bottom, and the life of a jolted converter bottom is 15% longer. The jolting takes about 5 min. under a pressure of 8 atmospheres. For firing, the heating up should take 24 hrs., the temperature should be maintained at 700°C for 24 hrs., and 48 hrs. should be allowed for cooling down. (*J.I.M.*)

Causes of cracks in large fireclay pots. ANON. *Brit. Clayworker*, **38** [449], 213–14 (1929).—Some causes of cracks in fireclay pots are (1) a change in the character of the clay which in turn will readily affect the character of the whole pot mix; (2) if the mixture is too plastic or too fat, cracking may be due to excessive richness; (3) if the mixture is too lean or short, the pots will be weak and may collapse too readily and would certainly be corroded rapidly in use; (4) errors in design of pots may cause weakness where strength is most necessary; (5) the majority of cracks in large pots are produced during drying. Whether natural or artificial drying methods are used, great care must be observed during this stage of manufacture. The firing of pots should be carefully made since rapid firing often causes failure of pots when in service. In charging a glass pot the initial material should not be dumped roughly into the pot. Pots used for low-temperature work should not be exposed to frost action. R.A.H.

Regenerators or recuperators. ANON. *Glashütte*, **59** [37], 661–63 (1929).—The advantages and disadvantages of various types of heat regenerators and recuperators for the glass industry are discussed and types of construction recommended. L.T.B.

Determination of permeability to gas of refractory materials. A. KANZ. *Arch. Eisenhüttenwesen*, **2**, 843–49 (1929); *Refrac. Jour.*, **4** [48], 400 (1929); for abstract see *Ceram. Abs.*, **8** [10], 745 (1929). E.P.R.

Lime for refractories and furnace construction. ANON. *Stone Trade Jour.*, pp. 18–19 (1929); *Refrac. Jour.*, **4** [48], 398 (1929).—Reference is made to the uses of lime in the construction of furnaces and refractories in general. The fluxing power of lime is so great that the proportion of it used in silica brick is necessarily low and for this reason it is undesirable to use an impure lime. E.P.R.

Apparatus for determining the crushing strength of refractory materials at very high temperatures: study of fused magnesia. G. CHAUDRON, M. GARVIN, AND A. VILLACHON. *Chimie & industrie* (Special No.), p. 330 [Feb.] (1929).—In order to see if large MgO crucibles would have the required mechanical strength for use on a commercial scale in a furnace, an apparatus was designed for accurately determining the crushing strength of refractories above 1600°. Pure MgO behaves satisfactorily at 2200°, undergoing only a viscous deformation; addition of 1.6% SiO_2 considerably increases the fragility at high temperature; Al_2O_3, Cr_2O_3, and Fe_2O_3·CaO apparently do not

affect the mechanical properties of pure MgO, the Fe_2O_3·CaO even reducing the viscosity slightly. (*C.A.*)

Investigations of the corrosion of refractory materials. II. Influence of the chemical composition of the slags. HERMANN SALMANG AND FRIEDRICH SCHICK. *Arch. Eisenhüttenwesen*, **2**, 439–47 (1929).—Quantitative tests were made to study the corrosive strength of slag on fireclay crucibles. The strength of the pure oxides decreases in the order: PbO, FeO, MnO, CaO, Fe_2O_3, K_2O, Na_2O, Mn_2O_3. Mixtures of the oxides have a smaller influence than the pure oxides. Boric acid attacks the crucible, but Al_2O_3 and SiO_2 do not. Additions of FeO and MnO to slag with high CaO contents (over 40%) increase the attack. For Part I see "Investigation of the Slagging Refractory Material" by H. Salmang, *Ceram. Abs.*, **7** [2], 85 (1928). (*C.A.*)

Industrial tests on refractory materials. SIMMONS. *Industrial Chemist*, pp. 338–41 (1929); *Refrac. Jour.*, **4** [48], 399 (1929).—S. refers to the apparatus devised at the Technische Hochschule (Berlin), for the testing of refractory materials. These include testing machines for (1) refractoriness under load, (2) expansion up to 800°C, (3) expansion up to 1600°C, and (4) spalling. The apparatus devised for refractoriness consists of (*a*) the electric furnace, (*b*) the testing machine for applying the load recording the expansion, (*c*) electrical control gear for the furnace, and (*d*) pyrometrical equipment. The furnace consists of a 10 cm. bore electric-resistance furnace employing finely-granulated retort carbon as the heat generating element. The second machine for determining the expansion up to 800°C gives a graphical representation of the expansion over the whole range of temperature for which it is suitable. The third machine for determining the expansion up to 1600°C, consists of heating a test piece in an electric furnace in which the resistance elements are silit rods. The machine for determining the spalling consists of a furnace for heating the brick, a water box in which the brick are cooled, and a frame in which the brick are clamped. The test pieces are heated to 850°C, immersed in water for 3 minutes and dried, the process is repeated until the test piece disintegrates. The number of repetitions required is taken as the spalling coefficient of the brick. E.P.R.

Method for testing refractory clays. ALBERT GRANGER. *Chimie & Ind.* [Special No.], p. 439 (1928); *Chem. Abs.*, **22**, 4745 (1928).—In testing refractoriness, the smallness of the test pyramids makes it difficult to detect the exact softening point. With some clays a test crucible was found to show signs of softening before the pyramid made from the same clay, while with others there was no noticeable difference. (*J.I.M.*)

Testing of refractory products. E. L. DUPUY. *Chaleur Ind.*, **9**, 801–802 (1928); paper read before the 2nd Congress on Industrial Heating (Paris), June 23, 1928. (For complete abstract see *Ceram. Abs.*, **8** [2], 122 (1929)). (*J.I.M.*)

New advances and objects in the field of refractories. J. KRATZERT. *Metallbörse*, **18**, 2441–42 (1928).—An account is given of the development of mullite refractories which are now manufactured on a large scale by heating clay and bauxite to 1600°C to obtain the compound $3Al_2O_3$·$2SiO_2$. Mullite has a melting point of 1850°C and is highly resistant to abrasion and slagging by the usual fluxes. (*J.I.M.*)

Developments in refractory materials. ALFRED B. SEARLE. *Fuel Econ. Rev.*, **7**, 65–71 (1928).—A general review of the sources and properties of the principal refractory materials, together with an account of the usual methods of grading, mixing, shaping, and firing these. A brief account is given of recent developments in the uses of refractories in various industries. (*J.I.M.*)

Refractories. F. T. RAUCH. *Chem. Eng. Mining Rev.*, **19**, 321–26 (1927).—Review of the composition and properties of refractories, with special reference to fire brick, is given. Particular mention of metallurgical purposes is not made (other than of

furnaces in general). In the sense in which the word refractory is used by furnace builders, it is defined as a material with the following properties: (1) a high softening and melting point; (2) a high compressive and transverse strength, both hot and cold; (3) resistance against the slagging action of the furnace contents if necessary; (4) sufficiently uniform expansion and contraction, within conveniently narrow limits; (5) resistance against sudden temperature changes; (6) resistance against mechanical abrasion or shock at high temperatures; (7) correct shape and dimensions, correct texture for every specific purpose, and correct specific gravity, thermal conductivity or resistivity, density, porosity, and permeability, and electrical conductivity or resistivity. The subject is exhaustively discussed from these points of view, with illustrative references to specific cases. (*J.I.M.*)

Behavior of ceramic products when subjected to sharp temperature variations. VLADIMIR SKOLA. *Tonind.-Ztg.*, **53** [31], 598–600 (1929).—The method of Parmelee and Westman (*Jour. Amer. Ceram. Soc.*, **11** [12], 884–95 (1928)) for determining the resistance of refractory material used in construction of regenerators to sudden temperature fluctuations was investigated and compared with other methods. (For previous reference see *Ceram. Abs.*, **8** [10], 733 (1929).) F.P.H.

Magnesia-graphite reactions at high temperatures. FRANK T. CHESTNUT. *Chem. Met. Eng.*, **35**, 687 (1928); for abstract see *Ceram. Abs.*, **7** [1], 32 (1929). (*J.I.M.*)

Refractories used in metallurgy: properties, tests. P. GILARD. *Rev. univ. mines*, **20**, 170–202 (1928).—The properties, uses, and tests of refractories are discussed in detail. (*J.I.M.*)

Appliances for the testing of refractory materials. F. FROMM. *Glückauf*, **65**, 144–46 (1929).—The refractories testing plant of the Verein zur Überwachung der Kraftwirtschaft der Ruhrzechen (Society for the Supervision of Power Economy of the Ruhr Collieries) at Essen is described. (*J.I.M.*)

Determination of the coefficient of heat conductivity. O. VLASOV. *Izvestiya Teplotekh. Inst.* (*Trans. Thermo-Tech. Inst.* [Russia], No. 6, pp. 32–44 (1928)).—The coefficient of heat conductivity of refractory materials, etc., is determined in a specially constructed apparatus which has the following features: a water-cooler section on the bottom, followed by an insulating layer, an electric heating element, a thermocouple, a second insulating layer, a thermocouple, a heating element, a thermocouple, the material under test, and a water cooler on the upper part provided with a thermocouple. The whole is pressed together, the elements are heated by direct current to insure a uniform temperature, which is very essential. The following advantages are claimed. The total mount of heat measured is equal to the amount of heat passing through the sample at the given difference in temperatures; the influence of side losses is actually elimienated. A very complete explanation and calculation is given, also many details of the temperature measurements. (*C.A.*)

Refractory materials. L. DESMARQUEST. *Refrac. Jour.*, **4** [48], 400 (1929).—A mixture of clay, Portland or like cement, and a gas-generating metallic powder is hydrated and molded. The mass is allowed to set and contract sufficiently for removal from the mold, after which it is further dried and finally baked at a temperature sufficient to dehydrate the cement and wholly or partly vitrify the ingredients. Chamotte, sand, sandstone, or silica may be used instead of (or in addition to) the clay. The clay may be preliminarily heated to a temperature of 200 to 1100°C less than the final baking temperature and sieved, a certain proportion of unfired clay being added to the mixture. The relative proportions of Portland cement and clay are varied according to the desired mechanical resistance, refractoriness, and specific gravity of the finished product. The mixture may comprise 40 parts cement, 50 parts fire clay baked at 400°C, 10 parts unbaked clay, and 0.12 part powdered aluminum. The generation

of gas is facilitated by use of ordinary or saponified water at a temperature of 40°C. The molds are greased and only partially filled with the mixture to allow for effervescence. E.P.R.

Results of comparative tests on slag brick. W. SCHÄFER. *Arch. Eisenhüttenwesen*, **2**, 363–66 (1928).—Compression tests on brick of blast-furnace slag show that the form of the test piece has a very considerable influence on the result. Tests were made on whole brick, half-brick, two half-bricks cemented together, and cubes and cylinders cut from brick. The resistance of different shaped specimens from brick of the same quality varied from 304 to 127 kg. per sq. cm. The reason for the great divergencies is not cleared up and further investigations are necessary. (*J.I.M.*)

Refractories in the steel industry. E. R. WALKER. *Chem. Eng. Mining Rev.*, **21**, 133–47 (1929); *Refrac. Jour.*, **4** [48], 399 (1929); see *Ceram. Abs.*, **8** [9], 660 (1929). E.P.R.

Effect of method of preparation of refractories on their physical properties. W. GROOTHOFF. *Tonind.-Ztg.*, **53** [49], 866–69 (1929).—A table is presented showing the effect of the method of preparation of refractories on (1) drying shrinkage, (2) firing shrinkage, (3) structure, (4) porosity, (5) mechanical strength, (6) resistance to spalling, and (7) volume constancy at operating temperatures. F.P.H.

Action of slags on refractory bodies. H. SALMANG. *Rev. mat. constr. trav. pub.*, No. 239, pp. 177–78B (1929).—Different substances were fused in crucibles of the following composition and porosity: SiO_2 56.52, Al_2O_3 and TiO_2 40.79, Fe_2O_3 2.42, porosity 14.4%. Contrary to opinion, the most easily fused slags do not give the greatest attack. The amount of action on the crucible depends upon the basicity and fluidity of the slag. Slagging action, in the order of decreasing intensity, was found to be as follows FeO, MnO, CaO, MgO, basic silicates, neutral silicates, and acid silicates. Phosphates dissolved the crucible almost as energetically as the oxides. Fe_2O_3 and Mn_2O_3 reacted more feebly than FeO and MnO. The complex silicates react more feebly as their basicity decreases. A table gives results of tests in the temperature range 1200 to 1600°C. A.J.M.

Note on the permeability of refractory materials. R. V. WIDEMANN. *Rev. mat. constr. trav. pub.*, No. 237, pp. 134–36B (1929).—W. warns that permeability and porosity should not be confused since there is usually no relation between the two. The apparatus used was simple. It consisted of a rectangular trough of iron in which the brick to be tested was placed. The brick was fastened firmly by means of screw clamps upon a ring of rubber which surrounded the gas entrance. The tightness of the contact was assured by a bath of mercury which extended from the contact to the upper face of the brick. The air or gas used in the experiments entered by means of a bottom outlet tube and the pressure (which remained constant during a test) was measured by a manometer. A meter permitted the determination of the liters of gas which traversed the sample. The coefficient of permeability, K, was calculated by means of the following formula: $K = Qe\sqrt{d/hs}$, where Q = number of liters of gas passing per hr., e = thickness of brick in cms., d = density of the gas relative to air, h = pressure in mm. of water, s = surface of the free face (upper) of the sample in sq. cm. Results obtained by this formula showed excellent agreement and the experimental values agree with those determined experimentally. The following data were obtained: (1) solid brick, $K = 0.19 \times 10^{-2}$, (2) brick with one surface skin intact, $K = 0.26 \times 10^{-2}$, (3) brick with no surface skin, $K = 0.27 \times 10^{-2}$. The following data were also obtained:

	Porosity (%)	Coeff. of permeability
Silico-aluminous refractory, 28% Al_2O_3	29	0.5×10^{-2}
Silico-aluminous refractory, 38% Al_2O_3	28	5×10^{-2}
Gas retort	26	4×10^{-2}

The permeability varies not only with the composition and nature of the product but also with the conditions of manufacture. The effect of temperature of firing is shown below:

Al_2O_3 (%)	Cone temperature of firing	True sp. gr.	App. sp. gr.	Vol. porosity	Coefficient of permeability $\times 10^{-2}$
20	16	2.55	2.03	20.5	0.47
20	13	2.59	1.74	33.0	0.90
20	10	2.63	1.73	34.0	0.63
28	16	2.60	2.15	15.5	0.00
28	13	2.61	1.82	30.5	0.78
28	10	2.63	1.80	31.5	0.35
35	16	2.63	1.90	27.0	1.7
35	13	2.63	1.76	33.0	1.6
35	10	2.63	1.73	34.0	1.2
Bauxite	16	3.01	2.07	31.0	4.7
"	13	2.96	2.14	29.5	0.6
"	10	2.97	2.13	29.5	0.3

A.J.M.

Modern fabrication of refractory masses. ANON. *Rev. mat. constr. trav. pub.*, No. 237, pp. 130–34B (1929). A.J.M.

Refractory materials and the carbonizing industries. ANON. *Gas-Jour.*, p. 661 (1928); *Tonind.-Ztg.*, **53** [33], 646 (1929). F.P.H.

Requirements of modern refractory materials. I. A. T. GREEN. *Blast Fur. Steel Plant*, **17** [9], 1395–1403 (1929); for abstract see *Ceram. Abs.*, **8** [3], 200 (1929). F.P.H.

Preparation of experimental sagger bodies according to fundamental properties. R. A. HEINDL AND L. E. MONG. Bur. Stand., *Jour. Research*, **3** [3], 419–44 (1929); *Ber. deut. keram. Ges.*, **10** [8], 368–72 (1929); for abstract see *Ceram. Abs.*, **8** [8], 590 (1929). R.A.H.

Properties of chamotte ware and their manufacture according to Scheidhauer and Geissing method. P. P. BUDNIKOFF. *Ceramics and Glass* [Moscow], II, 319–20 (1928).—B. describes a method of manufacturing fireclay products used already for more than two years by the Scheidhauer and Geissing Co. in Germany. According to this method the binding clay of the chamotte mass is diluted by adding, in special machines, soluble glass, potassium, humus materials, etc., dissolved in water. The mass obtained in this way contains only from 4 to 5% of water (as compared with from 18 to 25% by using the usual method). From 90 to 93% of chamotte can be mixed together with only from 7 to 10% of binding clay and still a homogeneous mass is obtained. The small amount of water considerably shortens the period of drying. Physical properties of products manufactured by this method are very high. The method makes it possible besides to cover the products obtained with a layer of carbide of silicon or another material by which the refractory properties of the products may be increased considerably. W.A.

Study of chrome and diaspore mixes. HARLOW G. JONES. *Jour. Amer. Ceram. Soc.*, **12** [11], 732–37 (1929).—The history, development, and properties of chrome and diaspore brick are discussed. The plan for this investigation was the determination of (1) softening points of various mixes, all of which withstood cones 33 to 34, (2) workability of mixtures, wherein it was found that bars of soft mud were workable with difficulty while no trouble was experienced with dry-press, (3) porosity and shrinkage on reheating, slag action, and spalling. Increasing the proportion of diaspore increased the shrinkage while the absorption remained about the same in all cases. Various slags from different sources were used in the investigation, and it was found that a small per cent of finely-ground chrome ore cut down slag action on diaspore while the addition of diaspore to

chrome increased its resistance to spalling action; conversely, the addition of finely-ground chrome to diaspore increased its resistance to spalling action.

Determining alumina content of high alumina clays. W. D. KELLER. *Brick Clay Rec.*, **75** [8], 492–96 (1929).—Clays in the diaspore area of Mo. vary in alumina content from below 40%, as in flint clay, to over 75% in the best diaspore. Not only is there such variation in the clay of the area as a whole, but the same condition is usually present in every first-grade diaspore pit. Since the flint, burley, second-grade, and first-grade diaspore clays (ascending alumina content series) have different refractory values it is essential that the clay from the pits be graded before manufacture into brick. K. organizes various means used by workers for judging the quality of the clay into a scheme or table for determination that will be logical and practical. This organization involves the use of the common physical properties of minerals, and its accuracy has been confirmed by checking with a number of analyzed clay samples. It is desirable in the grading and estimation of the alumina content of the clay that the error of estimation be not greater than 5%, that it be done quickly and without instrumental tests, and that it can be done by workmen without technical training. The several means of grading now used by men working in the pits include the blackish mark left on the clay by steel tools, such as the auger, the pointed wedge "gad," and the pick, when reducing the size of the boulders; the feel of the clay, whether rough or slick; the way it breaks, *i.e.*, the fracture; the sound given off when struck by a tool; the amount of "shot," oölites, or burls present; and, to a lesser extent, the grain; the way it "chews," *i.e.*, the abrasive action when ground between the teeth of the workman; and the "weigh," specific gravity, of the boulder. Each method is discussed in detail. In summary it is stated that the most usable and reliable distinguishing characteristics of the alumina content of high alumina clays are fracture, and the mark left due to abrasive action on steel. The scheme is also presented in a tabular form. E.J.V.

Glasshouse refractories of Europe. C. E. FULTON. *Bull. Amer. Ceram. Soc.*, **8** [10], 315–19 (1929).—The process of building up glass pots used at the Chantereine plant of the St. Gobain Co. (Thourotte, France), is described in some detail. The method is somewhat different from that used in the U.S. At Schwepnitz and Kamenz, Germany, pots have been made by the casting process for a number of years, using thin, light plaster molds which are easy to handle. At Thonberg, Germany, where the casting process has been started recently the slip has a water content of about 16% rather than 18% as at the other plants. At Scheidhauer and Geissing Co. (Düsseldorf, Germany), large refractory shapes are being made with only 10% raw bonding clay. Sillimanite pots were seen at Sheffield, England, and at the E. J. & J. Pearson Co., they were using a batch consisting of 50% grog and 50% raw Stourbridge clay, with a water content between 16% and 18%. E.J.V.

Laboratory tests of the chemical activity of ashes of solid fuels in relation to refractories. O. V. NEFEDIEVA AND N. G. PACUKOV. *Izvestia Teplotech. Inst.* [Moscow], **5**, 20–30 (1929).—Two methods of testing refractory brick as to their behavior toward the chemical activity of ashes and slags were used. One method was to determine the fusibility of mixtures of refractories and ashes; the other was a modification of Nesbitt and Bell's method (*Jour. Amer. Ceram. Soc.*, **6**, 296 (1923)) of surface interaction. According to the first method the sample of solid fuel was finely powdered (900-mesh/sq.cm.) and burnt. The ash was then powdered and samples were taken for fusion determinations. From the refractories small samples were taken from different parts and the powder was moistened with water, and, after addition of a 10% dextrin solution, made up into small cones for fusion experiments. Mixtures of refractory and ash were next prepared (3:1, 1:1, and 1:3) and each was thoroughly rubbed together in an agate mortar; a portion was then subjected to the fusion tests, and the rest heated in a current of oxygen, again

thoroughly powdered, and oxidized in an electric oven for 1 hr. Conical samples for fusion experiments of both the mechanical mixture and the heated mixture were prepared as described above. Curves showing the relation between constitution of the mixture and temperature of fusion exhibited in all cases, except one, a rapid decrease of fusion point to a 25% ash content, after which the decrease was more gradual and regular. It was also found that refractory brick with high silica content are more resistant. In the surface-interaction method a brick sample was weighed and measured, and the size of the hollow in one of its sides was determined by means of a volumeter, using pure sand. Its porosity was also determined. The hollow was then filled with ash and slag and the brick with the hollow upward was heated for a known period at a known temperature. After being cooled, weighed, placed with the hollow downward on a fire-resisting crucible to allow any molten ash which might escape to collect in the crucible, it was placed in an oven and kept for the same length of time at the same temperature. After cooling it was again weighed and measured, and from the measurements of the hollow the degree to which the brick was attacked by the given ash sample could be determined. (*B.C.A.*)

Preparation of alumina from volcanic ash as source of aluminum. ISAMU SEKI. *Repts. Imp. Ind. Research Inst. Osaka, Japan*, **10** [2], 22 (1929).—Japan lacks bauxite as a source of Al. Many attempts have been made in the past to prepare Al_2O_3. S. makes Al_2O_3 from volcanic ash containing 15 to 30% Al_2O_3. Volcanic ash is pulverized after being dried at 130°, heated at 400 to 700° for 2 hrs. in an electric oven, and treated with H_2SO_4. The solubility of Al_2O_3 is highest (99.5%) when the acid concentration is 30 Bé, and treatment about 30 min. $Al_2(SO_4)_3$ is best separated from $CaSO_4$ when the density of the solution is about 1.47. Fe is best removed from the $Al_2(SO_4)_3$ solution by a ferrocyanide solution but other methods may be used. Under such conditions the product obtained contains Al_2O_3 99.08, H_2SiO_4 0.86 and $Fe(OH)_3$ 0.06. (*C.A.*)

Basic processes of manufacturing alumina. G. G. URAZOV AND Y. E. VILNYANSKII. *Zhur. Prikladnoi Khim.*, **1**, 271–83 (1928).—$Na_2O{\cdot}Al_2O_3$ is formed by fusing Al_2O_3 and Na_2CO_3 at 500 to 1050°. The presence of NaCl has no appreciable effect on the reaction. The reaction rate increases with the increase in the amount of Na_2CO_3 present, but is also dependent on the nature of the raw material. For bauxites, fusion with Na_2CO_3 for 2 hrs. at 980° is recommended. Quick leaching with water leaves $^1/_4$ of the Al_2O_3 in an insoluble form. Addition of Na_2CO_3 to this water is of no benefit, but addition of NaOH ($^1/_3$ of the amount present in the melt) increases the yield of Al_2O_3 by almost 100%. Molecular ratio of Na_2O to Al_2O_3 in the solution is about 1.09 to 1.48 which is not in accordance with the Goudrian diagram (*C. A.* **15**, 478). (*C.A.*)

Magnesite refractories. N. H. HORN. *Chem. Eng. Mining Rev.*, **21**, 261–64(1929).—The geographical distribution of magnesite, methods of calcination, the properties of caustic and dead-burned magnesite and the manufacture and properties of magnesite brick are briefly discussed. The thermal conductivity of magnesite brick is high and decreases with temperature rise. The thermal expansion at high temperatures is about 1.56%. (*C.A.*)

Soda-lime process of manufacturing alumina from bauxites and aluminum silicates rich in silica. G. G. URAZOV, YA. E. VILNYANSKII, AND YA. V. MORACHEVSKII. *Zhur. Prikladnoi Khim.*, **1**, 77–96 (1928).—In fusing Al silicates with Na_2CO_3 the principal compounds formed are $Na_2O{\cdot}Al_2O_3$ and 1 to 1.5 $Na_2O{\cdot}Al_2O_3{\cdot}2$ to 2.5 SiO_2. Not more than 1 mol. of Na_2CO_3 should be present per mol. of Al_2O_3 and per 2 mols. of SiO_2; otherwise considerable SiO_2 is obtained in water soluble form. The residue insoluble in water has an approximate composition $Na_2O{\cdot}Al_2O_3{\cdot}2SiO_2$. Best fusing temperature is 850 to 950°. When nepheline ($Na_2O{\cdot}Al_2O_3{\cdot}2SiO_2$) was fused with CaO and the melt leached with water the insoluble residue contained all four oxides. The Al_2O_3 and Na_2O content of this

residue decreases with the increase in the amounts of CaO and SiO_2 present. When clay (SiO_2 44.25, Al_2O_3 38.73, Fe_2O_3 0.85, TiO_2 1.62, H_2O 14.44%) was fused with Na_2CO_3 and $CaCO_3$ more water-soluble Na_2O and Al_2O_3 were formed than with nepheline. The insoluble residue probably contains $3CaO \cdot SiO_2$. By leaching the melt with hot NaOH solution more Al_2O_3 is extracted but SiO_2 is also partly dissolved. The solution of the problem consists in finding conditions under which all of Al_2O_3 and no SiO_2 are extracted, but this could not be accomplished. (*C.A.*)

Barium process of manufacturing alumina from bauxites and aluminum silicates rich in silica. G. G. URAZOV AND A. W. CHITAEFF. *Zhur. Prikladnoi Khim.*, **1**, 96–109 (1928).—Ba aluminates are formed at higher temperatures than those of Na. Fusion at 1220° with $BaCO_3$ converts 88 to 98% of Al_2O_3 into water-soluble form, while at 1000° not over 55% Al_2O_3 can be extracted. In the presence of fluxes such as NaCl about 93% Al_2O_3 is converted into the water-soluble form at 1000°. Solubility isotherms of the system BaO–Al_2O_3–H_2O were investigated at 60°. Maximum solubility corresponds to 3.48% BaO and 1.129% Al_2O_3 by weight (Al_2O_3:$2BaCO_3$). No compounds are formed. Solubility isotherms of the system $Ba(OH)_2$–NaCl–H_2O at 60° show that no compounds are formed and that the highest solubility corresponds to a mixture of 1.17 mols. of BaO and 1 mol. of NaCl (the ratio may be even closer to one). NaCl increases solubility of $Ba(OH)_2$ by 1.52% only. Investigation of the system BaO–Al_2O_3–NaCl–H_2O at 60° showed that presence of NaCl has no effect on solubility. By fusing bauxites with Na_2CO_3 more Al_2O_3 is converted into a soluble form than by fusing with $BaCO_3$, but the Ba process yields a product with a low SiO_2 content as compared with the Na_2CO_3 process. (*C.A.*)

Dinas brick. V. E. GROUM-GRJIMAILO. *Jour. Russ. Met. Soc.*, **3**, 55–60 (1928) (in Russian). (*J.I.M.*)

Tridymitization of Dinas brick. V. N. SCHECOV. *Jour. Russ. Met. Soc.*, **3**, 61–71 (1928) (in Russian). (*J.I.M.*)

Fuel for melting metals. ANON. *Brass World*, **25** [9], 218 (1929).—Five hundred to 600 lbs. of metal are charged directly on top of the incandescent bed of fixed carbon fuel, and this charge is ready to tap into the pouring ladles in from 11 to 16 minutes. E.P.R.

Aluminum and bauxite. C. L. MANTELL. *Mineral Ind.*, **37**, 12–27 (1928).—The value of new aluminum produced in 1928 in the U.S. was $47,899,000, an increase of 22% as compared with 1927. As in previous years the principal producing plant was the Massena, N. Y. works, the remainder coming from Niagara Falls, Alcoa, Tenn., and Badin, N. C. The continued growth of the demand for aluminum, alumina abrasives, alumina cement, and aluminum salts has brought the world's production of bauxite up to considerably more than 1,700,000 T. France continues to be the largest producer, followed by the U.S., Hungary, British and Dutch Guiana. E.P.R.

Magnesite. PAUL M. TYLER. *Mineral Ind.*, **37**, 389–99(1928).—Formerly great importance was attached to the physical nature of crude magnesite, and amorphous (or cryptocrystalline) material was considered suitable only for making caustic calcined magnesite and crystalline magnesite was used exclusively for dead-burned material. In later years it has been found possible to employ crystalline magnesite, mined in Washington, for magnesite cements and the California amorphous material is now being made satisfactorily into high-grade refractories. For many purposes dolomite, or high-magnesium limestone, is an active competitor of magnesite. As a "war mineral" dead-burned magnesite assumed importance in connection with its use as lining for open-hearth steel furnaces. In the refractory field, magnesite meets active competition, not alone from dead-burned dolomite, but also from other highly refractory mineral products. Chrome refractories in particular, have found a much wider use, due in part to

the higher prices for magnesite in the U.S. since it became dutiable under the tariff act of 1922. Magnesite brick are quoted at $65 a short ton, which contrasts with $45 a ton for chrome brick. E.P.R.

Properties of Serbian magnesite. G. PETUNNIKOV. *Montan. Rundschau*, **21**, 276–79 (1929); *Refrac. Jour.*, **4** [48], 400 (1929).—The occurrence of large magnesite deposits in Serbia, the quality, composition, and other properties of the magnesite are discussed. E.P.R.

Relation of properties of various clays of the Westphalia and Rhine districts. FRITZ HARTMANN. *Ber. deut. keram. Ges.*, **10** [8], 353–61 (1929).—H. deals principally with the effect of composition of refractory clays upon their properties. It is pointed out that the method of manufacture of fire brick affects the resistance of the brick to slag action, resistance to spalling, softening behavior, and volume constancy of the brick. At the same time the chemical composition of the fire brick determines certain properties of the refractory. As the alumina content of the clay increases the loss on ignition of the raw clay also increases. The cone fusion of clays of constant iron and titanium contents increases as the alumina content increases and the softening range of clays under load behaves in the same manner. F.P.H.

Newly found bauxite deposits in the Otranto District, Italy. C. CREMA. *Mineria ital.*, **13**, 165–66 (1929).—Analyses show as high as 56% Al_2O_3. (*C.A.*)

New silica brick plant. H. HASBACH AND K. HELDT. *Tonind.-Ztg.*, **53** [34], 647–51 (1929).—The new plant of the Ukraine Silica Trust (Charkow, Ukraine), is described in detail. The company owns extensive deposits of quartzite in the Charkow-Nikitowka-Panteleimonowka district. The composition of Panteleimonowka quartzite SiO_2 95.74, Al_2O_3 1.40, MgO 1.08, CaO 0.44, crystalline quartz 27.6%, and amorphous bond material 72.4%. F.P.H.

BOOKS

Best Furnace Practice. FRED CLEMENTS. Ernest Benn, Ltd., London, 1929. Reviewed in *Engineering*, **128** [3322], 315–16 (1929).—The first volume deals with the general principles, the source, preparation, and handling of raw materials. The second volume is devoted to the design of plant and equipment. General layout of the plant, the arrangement of individual furnaces, the design of stock, bosh and hearth and the refractory materials for linings and stones are fully discussed. Relative merits of gas and steam engines and a discussion of various instruments and the underlying principles of their construction are also given. The concluding volume will deal with the actual operation of the blast furnace and the utilization of the subsidiary products. A.A.

Harbison-Walker booklet on "Firebond." ANON. *Amer. Glass Rev.*, **49** [2], 14 (1929).—"Firebond" is the title of an attractively illustrated booklet recently issued by the Harbison-Walker Refractories Co. The booklet of 12 pp. and cover, contains some new and useful tables for calculating the quantities of brick required for arches of different spans and thicknesses. E.P.R.

PATENTS

Baffle wall. JOHN E. MUHLFELD. U. S. 17,449, Oct. 1, 1929 (reissue).

Porous refractory diaphragm. RUSSELL E. LOWE. U. S. 1,731,053, Oct. 8, 1929. A surface combustion apparatus comprising a porous diaphragm having indentations in its front surface and two sets of webs on the surface, the webs of one set crossing those of the other at an angle, a gas chamber at the rear of the diaphragm, and means for introducing combustible gas and oxygen into the chamber.

Manufacturing glass-melting crucibles, etc., of clay. JULIUS HOCHHUT. U. S. 1,732,088, Oct. 15, 1929. The process of manufacturing glass-melting crucibles and similar refractory articles of clay, consisting in mixing clay with a ground leaning means

moistening the mixture with water only to an extent so as to obtain a loose incoherent mass, supplying the mass in small portions to an open mold while permanently stamping it therein, and drying and firing the shape thus obtained.

Producing high heat-resisting substances. HARRY M. WILLIAMS. U. S. 1,713,580, May 21, 1929. Process of producing high heat-resisting substances consisting in reducing at least a substantial portion of a nonoxidizable refractory material to an impalpable powder in the presence of a deflocculating agent, giving the desired form to a mass of the powdered material and heating the formed mass at such a temperature and for such a period as to cause the particles of the mass to cohere.

Refractory substances. HARTFORD-EMPIRE CO. Brit. 316,129, Sept. 18, 1929. A refractory ceramic body for use in contact with molten glass, composed principally by analysis of alumina and silica, of low porosity so as to be substantially impermeable to molten glass, and containing not materially more than 3% of total alkaline, iron, and lime fluxes and not over 1.5% alkaline and iron fluxes, is made by selecting raw materials substantially free from undesired fluxes and by a process involving fine grinding and intimate mixing of the raw materials, molding at great pressure, and firing at a temperature below fusion but sufficient to develop a micro-crystalline structure. *E.g.* a body of high silica content is made by intimately mixing 90 parts of washed Georgian Klondike white kaolin and 10 parts of Ark. clay, both in a fine state of subdivision, firing to form a grog which is broken down to pass a U. S. Standard No. 24 screen; 17 parts of this grog are then mixed with 20 parts of a binder formed of 65 parts of the kaolin, 5 parts of the Ark. clay, and 30 parts of finely ground potter's flint; the mixture is molded at a pressure of 5 T. to the sq. in. and fired at about 2850°F. The final product comprises two phases only, mullite crystals and glass and has a low porosity. In another example, a body of high alumina content is made of a grog, formed of 96 parts of raw aluminium monohydrate and $4^1/_2$ parts of raw Ark. clay, and a binder of the same composition fired at a temperature of about 3200°F. Other compositions are described. (*B.C.A.*)

Manufacture of carbon electrodes, etc. CARBORUNDUM CO., LTD. Brit. 294,176, July 13, 1928. When coke or silicon carbide, etc., is crushed it tends to break up into needle- or platelike particles. If such material is mixed with a bituminous binder and fed into a mold which is being jolted, the particles orient themselves so that their largest cross-sectional areas lie in a direction at right angles to that of jarring. When removed from the mold and fired at 1000°, the material forms a consolidated mass having a greater heat conductivity in one direction (at right angles to the direction of jolting) than in the other. A carbon electrode may thus be made having a greater lateral than longitudinal heat conductivity, which property increases the life of the electrode by decreasing the rate of oxidation of the upper portion. A suitable jolting machine is described. (*B.C.A.*)

Ceramic products. RUDOLF POLLAK AND WILHELM WEBER. Austrian 113,330, Jan. 15, 1929. Ceramic products of improved properties are obtained from alkali-free Mg silicates such as serpentine, chlorite, and steatite by mixing with the silicates an alkali-free alkaline earth compound ($BaCO_3$) and Al_2O_3 in a total amount not exceeding 10%, the finely-ground mixture being molded and fired in the usual way. Graphitic objects can also be obtained by mixing 30% or so of graphite with the mixture as above. (*C.A.*)

Manufacture of basic products for lining metallurgical furnaces. P. RIES AND F. BICHEROUX. Belg. 356,350, Jan. 31, 1929. Tar and a powdered mineral flux are added to a basic refractory which has been fritted and coarsely ground. The mixture is heated to a temperature slightly below the combustion temperature of the tar, the mass is molded under pressure, and finally baked at such a temperature as will give it the strength of ordinary refractories. (*C.A.*)

Alumina. JEAN C. SEAILLES. Fr. 34,230, Aug. 20, 1927. Addn. to Fr. 649,027; see *Ceram. Abs.*, **7** [11], 767 (1928). The $NaAlO_2$ lye of the prior patent is purified by treatment with Na_2S which acts as a reducing agent on any chromates, ferrates, silicates, vanadates, etc., present. An alkali zincate may be added before treatment with Na_2S whereby Ga is carried down and may be recovered. *Ibid.* Fr. 34,231, Aug. 20, 1927. Addn. to Fr. 634,430. Al ore and an alkaline earth base in the proportion of 3 mols. of base to 1 of Al_2O_3 and 1 to 3 mols. of base to 1 mol. of SiO_2 are calcined, and the mass obtained is treated with Na_2CO_3 solution to form $NaAlO_2$. *Ibid.* Fr. 34,239, Aug. 29, 1927. In the wet treatment of Al ores by alkaline earth bases, a mixture of CaO and BaO is used, the BaO acting as a sort of catalyst, the amount of CaO being sufficient to precipitate all the Al_2O_3 as $Ca(AlO_2)_2$. Fr. 34,249, Sept. 6, 1927, describes a process in which a mixture of BaO and CaO or NaOH or CaO and KOH is used. (*C.A.*)

Ceramic material. BORGESTAD FABRIKKER. Fr. 34,049, Sept. 14, 1927. Addn. to Fr. 623,573. A ceramic material is made from particles of natural olivine rock agglomerated with Mg orthosilicate obtained artificially, *e.g.*, from talc and magnesite. The olivine rock may be replaced partially or wholly by particles of Mg orthosilicate. (*C.A.*)

Refractory materials. FELIX J. MALHERBE. Fr. 656,923, July 3, 1928. Refractory materials particularly furnace hearths are hardened by impregnation with Na_2SiO_3 or K_2SiO_3 or both, so that the silicates penetrate into the interior and dry there, while the exterior is freed from silicate. The silicates may be used in solution in petroleum. (*C.A.*)

Ceramic material. I. G. FARBENIND. A.-G. Fr. 657,651, July 18, 1928. A ceramic material of high thermal conductivity has Si as an essential constituent. Thus, mixtures containing (1) pure finely ground Si 95, and milk of lime 5 parts, (2) ferrosilicon (90%) 50, clay matter 40, feldspar 5, cryolite 5 parts are baked in known manner. (*C.A.*)

Apparatus for accumulating and distributing intermittently molten glass. ADOLF SCHILD. Fr. 658,078, July 25, 1928. (*C.A.*)

Terra Cotta

Constant-pressure gravity tank for spraying slips and glazes. R. F. GRADY, JR. *Jour. Amer. Ceram. Soc.*, **12** [11], 728–31 (1929).—The difficulties in obtaining even coatings with gravity feed and the uniform results obtained with a tank equipped with a Mariotte tube are described. The construction and use of the device are explained and illustrated. This article was abstracted in *Ceram. Ind.*, **12** [4], 450–51 (1929).

Salt glaze. BERNHARD NEUMANN. *Sprechsaal*, **62** [36], 653–55; [37], 673–76 (1929).—The appearance and defects of salt glazes are studied by microscopic investigation. On porcelain, a homogeneous colorless and clear salt glaze is obtained while on stoneware there is no homogeneity; instead, a darker skin is superimposed upon a clear skin of irregular thickness. The surface reveals a scarred appearance of light and dark patches, the former within the depressions (often containing pinholes) and the latter forming the small elevations. The scars are due to gases emitted from the body during firing which penetrate the glaze. Subsequent heating will render the glaze soft enough again to heal the scars. Long firing and slow cooling of the ware after glazing are essential for homogeneity and a uniformly glazed surface. Wrinkles obtained in the glaze are due to rapid cooling where the gases from the interior meet the resistance of a fairly stiff glaze, and craters are formed when the gas finally escapes, breaking a hole through the raised skin. The fault of a "silvery" glaze (a matt dull but uniform surface) is also traced back to quick cooling. A rough cast appearance is due to ample salt glazing and "silvery" glaze to a deficiency. In a large kiln the above defects are local, mainly due to a lowering of temperature, and may be corrected by application of higher tempera-

tures. The second installment showed microscopically that the gases emitted are due solely to carbon deposited during firing within the porous body. The general appearance of the glaze is discussed and illustrated, and glass and iron-oxide formations are pointed out. Further investigation of faulty stoneware glazes is to follow. T.W.G.

Weather-resistant glazes for stoneware products. ANON. *Rev. mat. constr. trav. pub.*, No. 223, p. 93B (1928).—The following were found to be satisfactory:

0.2 K_2O 0.1 MgO 0.7 CaO	0.25 $Al_2O_3 \cdot 1SiO_2$	0.1 K_2O 0.2 CaO 0.1 MgO 0.1 ZnO 0.5 BaO	0.17 $Al_2O_3 \cdot 6SiO_2$
0.22 K_2O 0.39 MgO 0.39 PbO	0.27 $Al_2O_3 \cdot 1.92\ SiO_2$		

These are fritted glazes and they mature at 1200°C. A.J.M.

Action of freezing on fired clay products. HENRI GILARDONI. *Rev. mat. constr. trav. pub.*, No. 238, pp. 145–51B (1929).—An excellent review of the subject is given. A.J.M.

Preparation of the raw materials for mosaic tile. GUDMUND DAHL. *Rev. mat. constr. trav. pub.*, No. 224, p. 100B (1928).—For abstract see *Ceram. Abs.*, **7** [6], 381 (1928). A.J.M.

Qualities of a good tile. ANON. *Rev. mat. constr. trav. pub.*, No. 239, pp. 170–71B (1929).—The desired qualities are: (1) resistance to weathering (impermeability), (2) freedom from cracks or fissures, (3) resistance to shock and flexure, (4) adaptability and service as an effective barrier to rain, snow, wind, etc., (5) resistance to fire, (6) agreeable exterior appearance, (7) minimum weight, and (8) low price. These points are discussed. A.J.M.

Synthetic stoneware. ANON. *Brit. Clayworker*, **38** [449], 199 (1929).—For more than a year past a plant has been operating at Schameder (Germany), producing artificial stoneware under a patented process. The output has been meeting with successful commercial results. Such specialites as flower pots, vases, jardiniers, etc., are manufactured without the aid of furnace heat. The products contain no clay or cement. R.A.H.

Hotel Governor Clinton. ANON. *Arch. & Bldg.*, **61** [9], 264 (1929).—Following in design the north Italian style of the 12th Century with Romanesque detail, the Governor Clinton (New York City), rises from a base of stone in three pavilions of brick, capped by towers and terraces, with balconies of terra cotta. E.P.R.

Ceramics in church architecture. ANON. *Arch. & Bldg.*, **61** [9], 263 (1929).—The church of St. Rose of Lima, Newark, N. J., is described. The exterior is of rough cut stone with terra cotta trim extensively used and a slate roof. The walls are St. Même French stone, grey in color with rough plastered ceiling tones. There are marble floors in the aisles, laid in squares, with narrow strips of mosaic in green at the sides. E.P.R.

Origin of defects found in manufacture of Dutch tile stones. E. KILLIAS. *Keramos*, **8** [16], 591–600 (1929).—Some of the defects found in Dutch tile stones are traced to their origin in the working of the bodies and glazing of the ware. Methods of eliminating these defects are given. F.P.H.

BOOK

Handbook of Building Construction. Edited by GEORGE A. HOOL AND NATHAN C. JOHNSON. 2nd ed. McGraw-Hill Book Co., Inc., New York. Two volumes, Fabrikoid, price $10.00. Reviewed in *Arch. & Bldg.*, **61** [9], 293 (1929). E.P.R.

White Wares

Solubility of quartz and clay in feldspar. C. W. PARMELEE AND C. R. AMBERG. *Jour. Amer. Ceram. Soc.*, **12** [11], 699–710 (1929).—The literature on the subject is completely reviewed. The method used involved the addition of increasing amounts of kaolin to fixed amounts of feldspar and the addition of increasing amounts of quartz to fixed amounts of feldspar. All compositions were examined microscopically and the presence of undissolved kaolin was shown by the appearance of mullite needles, while the presence of undissolved quartz was shown by the presence of cristobalite. Soda feldspar is a better solvent for both quartz and clay than potash feldspar. The solution of quartz in soda feldspar starts at about 1350°C and increases with the temperature until at 1425°C, 32 parts of quartz per 100 of feldspar are dissolved. The solution of quartz in high potash feldspar does not start until 1400°C and only 4 parts are soluble at 1425°C to every 100 parts of feldspar. The solution of clay in soda feldspar starts at 1225°C and increases with the temperature until at 1425°C thirty-six parts are soluble. The solution of clay in high potash feldspar starts at 1250°C and at 1425° the solubility is 20.5 parts per 100 of feldspar. The solution of quartz in porcelain bodies starts at the same temperature as it does in the pure feldspar which the body contains. The amount of solution per unit of feldspar is much greater. The general trend of one of the boundary lines in the ternary system K_2C–Al_2O_3–SiO_2 has been found.

Comparative tests of chinaware using two forms of testing machines. G. W. WRAY AND C. M. BRAND. *Jour. Amer. Ceram. Soc.*, **12** [11], 716–24 (1929).—Two forms of impact testing machines designed to determine the resistance of chinaware to chipping and impact, and their use in testing chinaware are described. The results of testing 33 brands of domestic and foreign-made ware with these machines are given. In addition, the weight, dimensions, and percentage of water absorption of the ware are given.

Porcelain at cone 3. FRANK B. HODGDON. *Jour. Amer. Ceram. Soc.*, **12** [11], 725–27 (1929).—A body of the composition: clay 60%, frit 30%, and flint 10%, was mixed and ground until it passed a 200-mesh. It was cast, dried in the open air, biscuited to cone 08, glazed, and finished at cone 3. An excellent translucency and color resulted.

Shape of chemical porcelain casseroles. WILHELM VOLKMANN. *Chem. Fabr.*, **37**, 408–409 (1929).—An attempt is made for the standardization of porcelain casseroles and crucibles of various sizes in regard to shape, diameter, and cubical content. T.W.G.

Importations of porcelains and faiences into California. J. SIMON. *Rev. mat. constr. trav. pub.*, No. 239, pp. 182–83 (1929).—Useful statistics are given for the years 1926, 1927, and 1928. A.J.M.

Use of Seilitzer kaolins for manufacture of porcelain. E. BERDEL. *Ber. deut. keram. Ges.*, **10** [7], 335–38 (1929).—The rational analysis of Seilitzer kaolin is 70% clay substance, 17% quartz, and 13% feldspar. Porcelain bodies were made containing the elutriated Seilitzer kaolin and compared with similar bodies containing Zettlitz kaolin (elutriated). The working and casting properties of the bodies containing the two kaolins were compared. The elutriated Seilitzer kaolin is very plastic and can be substituted for other kaolins on the basis of its rational analysis. F.P.H.

Phonolite. ANON. *Sprechsaal*, **62** [37], 680–81 (1929).—The properties and chemical analyses of Teplitz phonolite are given. T.W.G.

Working of porcelain bodies with kneading machines. M. FLEROFF. *Ber. deut. keram. Ges.*, **10** [7], 321–25 (1929).—The uniformity of ware made with the use of the kneading machine (a type of chaser mill) was determined by cutting sections through the body and determining the shrinkage on each section. The column of clay was found to vary in uniformity depending on the method of operation of the machine. The re-

sults obtained with the use of the machine were compared with those obtained on a hand-wedged body and were not as uniform as those obtained by the latter method or by pugging the body. F.P.H.

Ivory china introduced by Theo. Haviland. ANON. *Crockery & Glass Jour.*, **107** [9], 54–55 (1929).—The new ivory china presents a beautiful transparent body of unusual quality and a depth of color that is exceedingly rich. It runs true to color with no more variation than white china, while its rich, heavy glaze gives it a beautiful sheen and velvety smoothness. The three great difficulties that were overcome were variety of color, opaqueness of body, and tendency of the coloring matter in the body to cloud and change some of the colors used in decorating the ware, thus limiting the number of colors which could be used satisfactorily. E.P.R.

BOOKS

Industrial Fabrication of Porcelain. I. MARC LARCHEVÊQUE. Published by Baillière et Fils, Paris.—General considerations of ceramics, clays, and preparation, firing of hard porcelain, decoration of porcelain and stoneware are presented. Reviewed in *Rev. mat. constr. trav. pub.*, No. 224, p.119B (1928). **II.** The following are treated: Firing of hard porcelain, combustion, solid combustibles, construction of ordinary kilns, fireboxes, means of control of firing generalities on the firing of hard porcelain, kilns using hot secondary air, muffles for the firing of colors, decorations. Reviewed in *Rev. mat. constr. trav. pub.*, No. 236, pp. 119–20B (1929). A.J.M.

Porcelain Industry. Complete Study of Materials for Sagger Making and for Firing. MARC LARCHEVÊQUE. Published by *Rev. mat. constr. trav. pub.*, Paris. A complete treatment of the subject is presented. For series of articles see *Ceram. Abs.*, **8** [10], 746 (1929). A.J.M.

PATENTS

Electrical insulator. OTTO PAUL ZIESCHE. U. S. 1,729,532, Sept. 24, 1929. In combination, an electric insulator body having a cavity therein provided with a restricted opening, a pin provided with a head having a lower face substantially at right angles to the axis of the pin extending into the cavity, a one-piece sleeve of continuous periphery buckled about its central portion to form an annular collar mounted on the pin adjacent its lower face within the cavity of the insulator body, and a metal filling cast into the cavity to fill the remaining interior space, the buckled portion of the sleeve being of greater diameter than that of the restricted opening of the cavity.

Insulating bushing. ARNOLD HALLER. U. S. 1,730,136, Oct. 1, 1929. Insulator construction comprising an insulator having peripheral depressions formed therein, a mounting encompassing the insulator between the depressions, and conductive material connected externally to the margins of the mounting and moulded into the depressions about the insulator.

Insulator. HAROLD B. SMITH. U. S. 1,730,171, Oct. 1, 1929. (1) A high-potential insulator comprising an insulating member having longitudinal surfaces intercepting lines parallel to the longitudinal axis of the insulator, oppositely-disposed terminal structures therefor each embodying a widely laterally-curved portion surrounding the axis in laterally-spaced relation thereto with the crest of the curved portion advanced toward the crest of the other to provide a tubelike field zone between the terminals in the portion of which corresponding to the wall of the tube the maximum field stresses of the insulator occur and inside of which wall-like portion the terminals are formed to provide a weakened field region in which electrostatic lines extend substantially parallel to the axis, the terminal structures also embodying portions to direct certain of the lines in the weakened-field region to conform substantially to the longitudinal surfaces of the insulating member. (2) An insulator comprising terminal members constructed to widely

distribute and definitely direct the electrostatic field thereof to have a zone of maximum potential gradient with a locus surrounding an axis through the members and a weakened portion between the zone and the axis, one of the members including an element operating to reform a portion of the weakened field portion, and an insulating member conforming to the reformed field portion supported by the element.

Making spark plugs. THOMAS WILLIAM WARREN. U. S. 1,731,280, Oct. 15, 1929. An apparatus for making spark plugs comprising a mold, a horizontal base thereto, a seat cut therein to receive one axial half of the spark plug, a support hinged to one end of the base, a central bore in the support, an annular seat on the support, a two part top to the mold hinged vertically at one end of the base, a locking means to the top part and base, a quarter seat cut in each part of the top, a cylindrical cup in the top of the mold one half cut in each part thereof, a central bore from the bottom of the cup to the interior of the mold, a plunger with compression rings adapted to reciprocate vertically and enter the cup and to compress molten insulating material in the cup into the mold.

Equipment and Apparatus

Resistance of metals suitable for dies to the abrasive action of plastic clay. ANON Bur. Stand., *Tech. News Bull.*, No. 149, p. 89 (1929).—The abrasive action of plastic clay in flowing through dies wears the liners rapidly and makes frequent renewals necessary. Although it is well known that different metals show different resistances to the abrasion of plastic clay, no data appear to be available showing the relative "wear values" of different metals, such as those used for lining dies. Such an investigation has, therefore, been undertaken by the Bureau. The work includes tests on different kinds of cast iron, steel, and bronze. Up to the present time 10 tests have been made on cast iron and 44 on carbon-chrome steel. A description of the method of determining abrasion losses is given. Results show that a carbon-chrome steel die shows $^1/_{10}$ less the abrasion loss from passage of clay than does a cast-iron die. R.A.H.

New plastometer. E. KARRER. *Ind. Eng. Chem.* (*Anal. ed.*), **1**, 158–60 (1929).—The new instrument is based on the compression that a sample undergoes when subjected to a given force for a given length of time. Two types of apparatus were constructed. The first type was operated by hand and was thus subject to personal errors. The second type is completely automatic. Detailed drawings of both types are given and the construction and operation are completely described. (Although constructed for use in measuring the plasticity of rubber, it seems possible that this instrument could be applied directly to the measurement of the plasticity of clays or ceramic bodies. Abstractor's note.) A.J.M.

Micro Saybolt-type viscosimeter. S. M. ROGERS AND L. R. ADKINS. *Ind. Eng. Chem.*, **20** [7], 742 (1928).—A new type of viscosimeter is described which differs from the Saybolt type in that it is constructed entirely of metal instead of glass and can be used for very small samples. R.G.M.

Recording psychrometers for control purposes. ANON. *Brick Clay Rec.*, **75** [8], 498 (1929).—A complete line of recording psychrometers for control purposes is now available from the Bristol Co. (Waterbury, Conn.). The recording psychrometers consist of two complete recording thermometer systems, including two sensitive bulbs and two pen arms mounted together in one case, one recording the wet and the other the dry bulb temperature. The self-contained type has liquid-filled thermometers that register up to 150°F on a uniform scale. The distance type is made in two classes for temperatures up to 212°F, one for an increasing scale chart which has surface tension thermometer bulbs, and the other having gas-filled bulbs is used for uniform scale charts. E.J.V.

Thermal elements for high temperatures in reducing atmospheres. J. A. M. VAN

LIÈMPT. *Rec. trav. chim.*, **48**, 585–88 (1929).—Since it is deemed advisable not to use Pt Pt-Rh elements for thermocouples for temperatures above 1000° and since Pt is rendered very brittle by traces of Si, van L. studied other elements in an attempt to find a satisfactory substitute. W-Mo, W-PtRh and Mo-PtRh elements were observed. The latter two were found to be satisfactory for use in reducing atmospheres. They also furnished twice as great a thermal e.m.f. per degree as the Pt Pt-Rh couple for temperatures between 1000 and 1600°. The W-Mo couple first showed a positive and then a negative e.m.f. (*C.A.*)

Heating water by means of a thermo-siphon. R. DUPUY. *Chaleur Ind.*, **10**, 30–36 (1929).—The physico-mathematical theory of the method is given. A.J.M.

Power-recording device applied to ore-crushing tests. ANON. *Eng. Min. Jour.*, **128** [2], 46 (1929).—Inter-mountain Expt. Sta. (Salt Lake City, Utah), in coöperation with the Univ. of Utah has developed a power-recording device for measuring the power input to rolls and which directly measures work applied to ball mill apparatus. The power input is determined to 1/1000 H.P. and is independent of motor efficiency, belt friction, slippage, etc. This device may be applied to other apparatus for accurate power readings. E.C.C.

Separation of particulate matter smaller than screen sizes into graded fractions. D. E. CUMMINGS. *Jour. Ind. Hyg.*, **11**, 245–56 (1929).—A technique of sedimentation is given by which dusts below 50 microns in diameter may be separated into graded sizes. A chart is given for the determination of the settling times of quartz particles of different sizes in water. H.H.S.

Removing oil from compressed air. SWERIN SHÜTZ. *Amer. Enameler*, **1** [5], 12–13 (1928). (Translated from the German by A. Kellner.)—Some uses of compressed air make it essential to keep oil out. The oil separator is inserted; by forcing the air through a layer of water the oil is thrown off. The irrigation process may be used by dripping water against air flow. It may be necessary to send the air through a filter of cotton or fine wood shavings. Silica gel or coke may be used as the filter. E.R.

Use of compressed air in ceramics, especially in manufacture of brick and tile. ANTOINE RAYMOND. *Rev. mat. constr. trav. pub.*, No. 237, pp. 121–22B (1929). A.J.M.

Air separation of fine-ground rock products. H. W. GONELL. *VDI-Zeitschrift*, **72** [27], 945–50 (1928); *Rock Prod.*, **32** [19], 90 (1929).—G. describes briefly the various processes used for determining the granular composition of various materials of which the air-screening process at normal room temperature is preferable, and presents an improvement upon the Pearson and Slight apparatus described in Bur. Stand., *Tech. Paper*, No. 48 (1915). F.P.H.

Eliminating dust and reducing fuel. ANON. *Ceram. Ind.*, **13** [4], 367–68 (1929).—Considerable dust had been observed around the scales where the batch was weighed, and also around the doghouse where the fill was made. This dust was usually driven upward by the current of hot air prevalent in the vicinity. In time, some of this dust, a part of which is caustic, would find its way into the nose and throat of the workman and also into the machinery about the plant. To arrest this dust, a large inclosure was placed about the place where the raw batch was loaded and a sheet-iron hood was placed above the doghouse. From both of these dust collectors is a sheet pipe about 8 in. in diameter, connected with a small blower. The latter sends the dust through another pipe into a conical shaped bin to which a large cylindrical receptacle is fastened. There has been a noticeable absence of dust in this portion of the plant since the installation of this equipment. (Carr-Lowrey Glass Co.) F.P.H.

Impact mills for grinding fire clay. O. M. TUPPER. *Mining and Met.*, **10** [274], 445–46 (1929).—Requiring a finer ground clay than that obtainable with a dry pan or

hammer mill, the Clay Corp. of Calif., installed a 5-roller, low-side Raymond impact mill at its Lincoln plant in 1925 and since then has been economically grinding fire clay with a moisture content as high as 15%. The grinding process is as follows: fire clay crushed to approximately 3-in. size is fed from the storage bins to the mill chute by means of apron feeders. The clay falls over the die-ring, part of it being caught by the revolving rolls and the remainder falls to the bottom of the mill where it is scooped up by the plows, which are also revolved from the vertical mill shaft, and fed to the die-ring directly ahead of the rolls. The air enters the mill through the ports under the ring and carries the finer material up to the discharge, dropping oversize particles back into the mill for regrinding as the air rises. The rate of feeding the crushed clay to the mill is controlled automatically by a pneumatic feed control. A suction nozzle pointing in the direction in which the air flows is placed on the intake side of the fan at such a point as to get the maximum amount of suction. A smaller pipe extends down into this nozzle to obtain pressure changes at this point. These pipes are connected to a controller which opens the suction line from the fan to the pawl-lifting mechanism when the pressure reaches a certain point and closes it when the pressure falls. At the time of closing the controller also opens the line from the pawl-lifter to the atmosphere so that the free air can enter and allow the diaphragm on the pawl-lifter to expand and thus engage the pawl with the ratchet and so start the feed to the mill. The point at which the controller opens the suction line, and so stops the feed to the mill, is regulated by a thumb-screw adjustment, thus giving a heavier or lighter feed as desired. The correct feed can be easily determined with a little experience, as the mill pounds and causes great vibration when either underfed or overfed. F.P.H.

So-called Kick law applied to fine grinding. A. M. GAUDIN, JOHN GROSS, AND S. R. ZIMMERLEY. *Mining and Met.*, **10** [274], 447–48 (1929).—According to this law energy output is larger than energy input in grinding to the finest sizes. The so-called Kick law is generally accepted to mean that for each reduction to one-half in particle diameter, in a unit weight, the same amount of work is required. In crushing-efficiency calculations on crushing tests it is customary, when basing the calculation on Kick's law, to assign ordinal numbers to each standard sieve size. These ordinal numbers increase by a constant difference with each successive sieve aperture, because standard sieve apertures are in constant ratio. Minus 200-mesh is generally assumed as equivalent to 37 microns in size. The experimental work shows the theoretical efficiency in crushing quartz to be about 3% on the basis of Edser's value for the surface energy of quartz. From this it follows that in coarser crushing, the Kick law gives efficiency figures that are lower and in fine crushing gives figures that are higher. That the energy required in fine grinding, according to the Kick law, results in an energy output greater than the input is conclusive proof of its fallacy. We cannot admit of any crushing or other operation reaching 100% efficiency, much less passing this by many fold. F.P.H.

Design and construction of dies for auger machines. KOHLER. *Tonind.-Ztg.*, **53** [37], 664–67 (1929).—A discussion is given of the effect of the die construction upon the shape of clay columns formed by auger machines. F.P.H.

Dickson apparatus for determining fineness of Portland cement. H. RICHARZ. *Tonind.-Ztg.*, **53** [46] 815–16 (1929).—Described in *Cement and Cement Manufacture*, No. 245 (1929). F.P.H.

Drying of clay goods. G. LAVELLE. *Pottery Gaz.*, **54** [628], 1587–91 (1929).—No single problem in the drying and processing of materials has made a greater demand upon the specialized knowledge and experience of the air-conditioning engineer than that of successfully and efficiently drying the many forms of clay products. No product is more delicately susceptible to all the factors that govern the final state of a material from which water is being evaporated than objects shaped from plastic clay. The qual-

ity of the finished form, depends on successful drying. The fallacy of the old air-drying method is pointed out. Some of the terms used in a discussion of modern drying practice are defined. The modern drying system by air-conditioning is outlined. Evaporation, vapor pressure, and air circulation are discussed in their relation to one another. The working out of drying schedules is explained. Different types of automatic-control instruments for drying ceramic ware are described. The advantages of scientific vs. natural drying are pointed out. E.J.V.

Zehner "regenerative drier." A. HARTMANN. *Tonind.-Ztg.*, **53** [17], 327–29 (1929).—A detailed description is given by H. of the Zehner drier (German Pat., 462,095) which has been in use for $2^1/_2$ yrs. The drier is built over a ring furnace and for this reason air of any temperature or humidity required can be drawn from the ring furnace as the various chambers of the furnace are always at different stages of the firing schedule. This is accomplished by an elaborate system of air ducts leading from the furnace to the drier. The thermal efficiency of such driers is high due to the close proximity of the drier and furnace supplying the waste heat. F.P.H.

Causes of poor functioning of a drying installation. P. THOR. *Rev. mat. constr. trav. pub.*, No. 222, pp. 64–65B (1928). A.J.M.

Artificial drying. V. PINKL. *Rev. mat. constr. trav. pub.*, No. 230, pp. 243–48B (1928); see *Ceram. Abs.*, **8** [4], 269 (1929). A.J.M.

Modern natural driers. R. BURGHARDT. *Rev. mat. constr. trav. pub.*, No. 235, pp. 73–78B (1929).—Many illustrations of drier construction are given. A.J.M.

New "American" clay feeder. ANON. *Clay-Worker*, **92** [3], 215 (1929); *Brick Clay Rec.*, **75** [7], 432 (1929).—A new clay feeder of the disk type, characterized by slow-speed operation, multiple position feed, easily controlled flow of clay stream, positive feed without spilling, and total absence of supporting brackets, has just been announced by the W. A. Riddell Co. (Bucyrus, Ohio). This feeder, because of its reliability, low-operating cost, and simplicity, has a place in every plant where proper control of prepared clay to pug mill or mixers is desirable. A detailed description is given of the new feeder, its construction and operation being discussed. E.J.V.

Argillaceous and siliceous materials and products. XIII. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 237, pp. 136–40B (1929).—R. presents a discussion of cutters for bricks, etc. Illustrations are given. **XIV.** *Ibid.*, No. 238, pp. 157–59B.—The discussion of cutting machines is continued. **XV.** *Ibid.*, No. 239, pp. 173–76B.—Various types of cutting machines are described and illustrated. For Parts I to XII see *Ceram. Abs.*, **8** [10], 746 (1929). A.J.M.

Remote control. D. H. KILLEFER. *Ind. Eng. Chem.*, **20** [7], 683–86 (1928).—K. presents a complete discussion of remote control, its application, and types of equipment used to produce it. R.G.M.

Chromium in auto manufacture. ANON. *Abrasive Ind.*, **10** [10], 47–48 (1929).—Chromium belongs to the same group as molybdenum, tungsten, and uranium and is found in various parts of the world. Chromium is harder than the hardest steel and harder than many of the gem stones, approaching the hardness of the ruby and sapphire. Its extreme hardness, great resistance to corrosion, and high temperatures and high reflectivity, are characteristics which give it a wider application than any other metal. The ore from which it is obtained is found in large quantities in many parts of the world, but because of cheap labor, 70% of the supply comes from Africa. The ore is also found in western U.S., in India, and New Caledonia. E.P.R.

BOOKS

Elements of Industrial Engineering. G. H. SHEPHARD. Ginn & Co., Ltd., London 1929. Price 21s. Reviewed in *Engineering*, **128**, 225 (1929). H.H.S.

Technique of Drying. H. HIRSCH. 366 pp. Published by Julius Springer, Berlin. In the first part scientific principles and methods of calculation are given while the second part is devoted to practical applications. Reviewed in *Chaleur Ind.*, **10**, 49 (1929).

A.J.M.

PATENTS

Unloading granular materials. LIONEL COKE HILL. U. S. 1,728,968, Sept. 24, 1929. In an unloading device, a power scoop for handling granular material comprising a frame, a propeller having an irregular outer bearing surface adapted to rest upon granular material, the propeller being rotatably mounted in the frame, a power unit mounted on the frame and adapted to rotate the propeller to move same over the granular material, and a shoe plate secured to the machine and adapted to compact the material as it passes thereover.

Means for indicating quantities required for the correct operation of continuous processes. GEORGE WILLIAM BOST. U. S. 1,729,500, Sept. 24, 1929. Means for indicating quantities required for the correct operation of continuous processes in which an input quantity depends upon the values of an independently variable or controlling quantity, comprising in combination, an electrical indicator having voltage-current coils and a scale calibrated in terms of the required values of the input quantity corresponding to the values of the variable quantity, a pointer coöperating with the scale, means comprising a circuit having the voltage coil and a voltage controlling means connected therein for varying the amount of movement of the pointer, a second indicator having its voltage coil in an independent circuit, voltage controlling means in the latter circuit, and an electrical circuit connecting the current coils of the indicators in series and having means for controlling the current in the last-named circuit in accordance with the independently variable quantity.

Tunnel drier. MAURICE CHARLES HENRI OCTAVE LECOCQ. U. S. 1,729,675, Oct. 1, 1929. A hot-air drier comprising a tunnel through which the materials to be dried are passed and provided with air intake passages, means forming at will one or more air circuits, each of the circuits being provided with a heating battery and a fan or ventilating element, adapted for controlling the temperature and intensity of the air, the air circuits being adapted under certain conditions of being reversed or combined so as to form a single circuit.

Separating solid materials. H. M. SUTTON, W. L. STEELE, AND E. G. STEELE. Brit. 307,526, May 1, 1929. Relates to apparatus for separating granular material, such as a mixture of coal and heavy impurities, of the kind in which the materials are given a jigging movement on a pervious reciprocating deck which comprises receiving and delivery portions set at an angle to each other and through which upward currents of air are passed. The invention is described as applied to apparatus having the Y-shaped separating deck and described in specification 207,094, and comprises (*a*) inclining the delivery ends upward relatively to the receiving portion of the deck, (*b*) forming riffles of L-sectioned perforated strips, the horizontal arms of which are lifted slightly from the surface of the deck so as to avoid obstruction of the deck perforations by particles carried in the air stream; and (*c*) providing means at the central deck rib for directing a current of air across the path of flow of the materials over the deck. The perforated riffles taper down toward the central unobstructed passage on the deck and are combined with the usual solid riffles to form troughs in which the effect of the air pressure is reduced so as to facilitate the settling of the small particles of heavy material which are conveyed by the troughs to the passage. In order further to control the air pressure in the areas occupied by the riffles, perforated metal troughs with closed ends are secured to the under surface of the deck.

Kilns, Furnaces, Fuels, and Combustion

Tunnel kiln installation for porcelain insulators. E. H. FRITZ. *Jour. Amer. Ceram. Soc.*, **12** [11], 711–15 (1929).—Several novel features are to be found in this installation relating to the design and operation of the tunnel kiln. A description of these is given.

Lavino pioneers in high-temperature tunnel kilns. ANON. *Brick Clay Rec.*, **75** [8], 482–92 (1929).—A new tunnel kiln, built by American Dressler Tunnel Kilns, Inc., has been installed at the plant of the E. J. Lavino & Co. (Plymouth Meeting, Pa.). It embodies the most advanced design and engineering features brought out in tunnel kilns to date, and is the second tunnel kiln to be installed at the plant. The combined production of the two kilns is 22,500 nine-inch equivalents daily on a normal operating schedule. The product is uniformly high grade and substantial savings in fuel and labor have been made. Oil is used as fuel on the old kiln and city gas on the new unit. Both chrome and magnesite brick are fired in the same kiln. The new kiln is 325 ft. 6 in. long, 7 ft. 9 in. wide inside, and holds 60 cars of ware. The maximum temperature attained in the hottest part of the kiln is 2800°F, and this high temperature is obtained in a firing zone 123 ft. long. The burners, of a special design, are described in detail, as is the fuel control. An installation of radiation pyrometers directly connected to recording instruments is of great interest. One of the unusual structural features of the Dressler kiln is the design of the backstays in the hot zone. A Miller kiln of the twin tunnel type is also being operated. Details of operation and equipment of the plant are discussed. E.J.V.

Modern practice crystallized in new tunnel kiln. GEORGE S. HOUSMAN AND GILBERT E. SEIL. *Chem. Met. Eng.*, **36**, 340–43 (1929).—A new Dressler tunnel kiln is described. (*C.A.*)

Tunnel kiln in brick industry. WERNER-MORITZ. *Rev. mat. constr. trav. pub.*, No. 234, pp. 49–52B (1929). A.J.M.

Improved electric furnace heating element. W. ROSENHAIN. *Z. Metallkunde*, **21** [7], 239–40 (1929).—The heating element of the electric furnace described is comparatively cheap in construction and operation and can be used at 1400°C for long periods without replacement. It consists of two graphite rods of high conductivity. Between them are arranged, end on end, cylindrical pieces of carbon of high resistance, so that the whole element consists of a rod which is enclosed in a gas-impermeable protection tube of "Pythagoras mass." A furnace of seven of these elements showed very little oxidation of the carbon or any other detrimental effects when run at 1200 to 1400° for several days. L.T.B.

Electric furnaces for firing majolica and glazed ornaments. G. MILANI. *Corriere ceram.*, **10**, 43–45 (1929). (*C.A.*)

Rôle of air in the operation of a circular kiln. K. O. SCHULZ. *Rev. mat. constr. trav. pub.*, No. 236, pp. 102–104B (1929). A.J.M.

Stoneware firing in intermittent and chamber kilns. ANON. *Rev. mat. constr. trav. pub.*, No. 232, pp. 10–13B (1929). A.J.M.

Length of the preheating zone in ring furnaces. P. THOR. *Tonind.-Ztg.*, **53** [36], 680–81 (1929). F.P.H.

Recalculating foreign periodic kiln heat balances. CARL LOESER. *Sprechsaal*, **62** [35], 634–37 (1929).—Tables of heat balances are given and American figures correlated with L.'s figures. The figures show the possibility of getting along with twice the amount of theoretical air and even less if the furnaces are designed and operated with recuperation. For Part I see *Ceram. Abs.*, **8** [7] 524 (1929). T.W.G.

Firing roofing tile. ANON. *Tonind.-Ztg.*, **53** [34], 651–53 (1929).—The firing of roofing tile in periodic and ring kilns is described and compared. F.P.H.

Reactions in shaft kilns. HAUENSCHILD. *Zement*, **18**, 3 (1929); *Rock Prod.*, **32** [20], 88 (1929).—According to Huehl, there is the possibility of these six fundamental reactions between the substances under consideration:

(1) $2C + O_2 = 2CO$ (not reversible)
(2) $C + O_2 = CO_2$ (not reversible)
(3) $2CO + O_2 = 2CO_2$ (reversible)
(4) $2CO_2 = 2CO + O_2$ (reversible)
(5) $C + CO_2 = 2CO$ (reversible)
(6) $2CO = C + CO_2$ (reversible)

The discussions concern reactions 5 and 6, the occurrence of one or the other depending on the position of balance between the reaction 5 and 6, and this again is determined by pressure and temperature. The relations of balance between C, CO, and CO_2 at atmospheric pressure are as follows:

°F	932	1112	1292	1382	1472	1652	1832
% CO_2	95	77	42	25	7	3.5	0.7
% CO	5	23	58	75	93	96.5	99.3

F.P.H.

Precautions with kiln feeders. ANON. *Brit. Clayworker*, **38** [449], 196–97 (1929).—Some defects are inherent in certain automatic feeders for coal to continuous kilns and can only be avoided by using one of different design. Some feeders are of such a shape that the hopper is directly over the feed hole and becomes hot enough to set the coal on fire or cause smoldering and evolve acrid fumes. The more uniform the size of the pieces of coal and the more readily it runs the better will the feeder do its work. The amount of fuel delivered must be capable of rapid and easy variation. R.A.H.

Mechanical stokers. HANS DENDL. *Tonind.-Ztg.*, **53** [43], 752–53 (1929).—A description is given of several types of mechanical stokers used in the German ceramic industry. F.P.H.

Chemistry and physics of the combustion of gaseous fuels. G. E. SEIL, H. A. HEILIGMAN, AND C. N. WITHROW. *Gas Age-Rec.*, **64** [11], 344 (1929).—Given before the Minneapolis meeting, Division of Gas and Fuel Chemistry, American Chemical Society. The reasons for desiring to control the chemical constituents of the furnace atmosphere are discussed. In this connection the chemical and physical effects of excess CO, excess O_2, neutral atmosphere, and varying atmosphere are enumerated. The atmosphere in gas-fired tunnel and periodic kilns is traced throughout the burn, and compared to coal-fired kilns. Control of kiln atmosphere when using solid, liquid, and gaseous fuels is discussed. Various methods of burning gas industrially are described, with a full discussion of an annular orifice type burner. This burner provided its own venturi for inducing air, and can use air which is too hot to be compressed. This burner can be used in conjunction with a rigid venturi block. Curves and experimental data on producer gas, city gas, and oil burning are shown. F.P.H.

Carbonization of different types of coal. P. SCHAEPFER AND H. RUF. *Gas Age-Rec.*, **64** [13], 420 (1929).—The most important work on the methods of evaluating coal for the dry distillation process at high temperature and the articles in the literature on carbonizing installation are critically reviewed. A new apparatus for the distillation of coal samples up to one kg. in weight at any desirable adjustable temperature is described. F.P.H.

Gasification and practical operation of gas producers. H. GUILLON. *Chaleur Ind.*, **10**, 37–43 (1929).—G. discusses the gasification of solid combustibles. Various types of gas producers are described and their uses are given. A.J.M.

Gasification of coal in producer. F. MORAWSKI. *Gas Wasserfach*, **72**, 149–54 (1929); *Gas Age-Rec.*, **64** [12], 384 (1929).—Coal may be continuously gasified by means of air, a mixture of air and steam, or a mixture of air and combustion gases containing carbon dioxide. Assuming pure carbon to be gasified and the gas to lose no sensible heat on leaving the producer, gasification with air yields per kg. of carbon, a gas having a

heating value of 5688 kg. cal., a temperature of 1318°C, which gives a combustion temperature of 2252°C. For gasification with air saturated with moisture at a temperature of 60°C and with air and combustion gases containing 21% of carbon dioxide the corresponding figures are 7488 kg. cal., 400°C, 2082°C, and 6908 kg. cal., 562°C, and 1904° C, respectively. A truer comparison is obtained by reckoning the figures on the cold gas at 0°C. Thus the gas from the air alone, air-stream mixtures, and air-carbon dioxide has calorific values of 1050, 1570, and 1054 kg. cal. per cubic meter, with combustion temperatures of 1648°C, 1949°C, and 1644°C, respectively. The best results are obtained using an air-steam mixture. The above calculations assume complete decomposition of the steam, which is justifiable, and the production of carbon monoxide and no carbon dioxide from the carbon. The latter assumption is not quite so sound, and curves are drawn from which the necessary corrections can be made. Mixtures of air and water vapor can be produced either by the direct introduction of steam into air or by saturating air with vapor by contact with hot water. The latter method is more practical and economical. F.P.H.

Practical gas-temperature measure. GEORGE V. SLOTTMAN. *Blast Fur. Steel Plant*, **17** [9], 1344–45 (1929).—When determining the temperature of a hot gas care must be exercised to account for radiation to or from the thermocouple itself. Haslam and Chappell have studied the problem from a theoretical standpoint and find that the temperature as measured by a thermocouple in a gas stream is actually the temperature of the thermocouple tip, which is in equilibrium with the wall and gas temperature. At this equilibrium, the heat being radiated from the walls (assumed hotter than the gas) is equal to the heat being transferred by conduction and convection from the thermocouple tip to the gas. This equilibrium is expressed mathematically as follows: $h_c(T_c - T_g) = 0.162\ p\left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T_c}{100}\right)^4\right]$, the left side of the equation representing the rate of heat transfer from the thermocouple tip to the gas; the right side the rate of heat transfer from the hot walls to the thermocouple tip. h_c = coefficient of heat transfer through gas film; T_c = temperature of thermocouple; T_g = temperature of gas; T_w = wall temperature; and p = radiation factor. From this equation, three possible cases arise: (1) The walls and the gas are at the same temperature. Convection and radiation will be zero and the couple will read the true gas temperature. (2) The walls are hotter than the gas. Radiation from the walls to the thermocouple tip will cause the thermocouple to read high. (3) The walls are colder than the gas. Radiation from the thermocouple tip to the walls will cause the thermocouple to read low. In refractory-lined flues containing gas at a constant temperature (1) applies for practical purposes; (2) and (3) are met with in all operations where hot gas is passing through metal ducts; or where gas of varying temperature passes brick heated or cooled by a previous passage of gas at a different temperature. Metal boiler stacks, the regenerative system of the open hearth, and the waste gas and air ducts of the open hearth can be cited as examples. Of the methods used to determine the true gas temperature under these conditions, available for practical purposes are the high velocity couple of Haslam and Russell, and Wenzl and Schwarz, and the heating or cooling of the thermocouple tip as used by H. Schmidt. F.P.H.

Use of gas for firing kilns. ADOLF MENDHEIM. *Ber. deut. keram. Ges.*, **10** [7], 326–34 (1929).—A general discussion is given of the history and use of gas for firing compartment and tunnel kilns. F.P.H.

Explosive limits of industrial gases. J. S. YEAW. *Gas Age-Rec.*, **64** [11], 244 (1929).—(Minneapolis meeting, Division of Gas and Fuel Chemistry of the American Chemical Society.) The relation between the composition and the explosive limits of widely varying complex inflammable gas mixtures, generally encountered in the manu-

facture of city gas is shown. The range of observation covers gas mixtures containing from less than 12% to more than 96% combustible. The inflammable constituents include varying amounts of hydrogen, carbon monoxide, methane, and other hydrocarbons. The effect of the explosive limits of changes in the percentages of illuminants, methane, inert gases, and the ratio of hydrogen to carbon monoxide is pointed out and discussed. F.P.H.

Oil firing of refractories. ROBERT C. ZEHM. *Jour. Amer. Ceram. Soc.*, **12** [11], 742–45 (1929).—Notes on the construction and condition of kilns used for refractories, comments on the results obtained when firing with fuel oil, and data on the equipment and operation of the kilns, are discussed in this paper.

High-temperature experiments. I. Preliminary conditions and materials. WILLI M. COHN. *Metallwirtschaft*, **8**, 367–71 (1929).—At high temperatures stable compounds are rare, the tendency being to split into simpler substances, elements or even atomic nuclei with few electrons. Star spectra indicate temperatures for their atmospheres of 3000 to 30,000°, while the interiors may be as high as 40×10^{80}. In high-temperature studies one must have control of the speed of heating, maintenance of a given temperature for a known length of time, production of an oxidizing, reducing or neutral atmosphere, a sufficiently large volume of heating space, etc. As materials for furnace construction ceramic products, earths, alkaline earths, free elements of high melting point, oxides, nitrides, and carbides are listed and their physical properties recorded. From these may be selected materials suitable for working up to temperatures of 3000°. By isolating the high-temperature zone from the rest of the apparatus (as by air layers, vacuum, etc.) higher temperatures may be attained. (*C.A.*)

Carrying out investigations at high temperatures. WILLI M. COHN. *Metallwirtschaft*, **8**, 599–602, 623–30 (1929); see preceding abstract.—Furnaces for use at temperatures of 1500 to 3000° are now important. Materials of construction, theories of operation, and descriptions of various types involving the use of gaseous liquid and solid fuels, electric resistance, induction, and high-frequency furnaces are given. For obtaining temperatures above 3000° arc furnaces of 4 types and cathode-ray furnaces are explained. No materials are available that will remain in the solid condition at atmospheric pressure above 4000° absolute. The use of electric sparks, one or several explosions of solid or gaseous materials, etc., give such temperatures, but only for a short interval and cause difficulty in measuring the temperatures attained. (*C.A.*)

Study of the induction tube and its effect upon combustion. H. MISOSTOW. *Power*, **70** [13], 484–85 (1929).—The article gives a description of combustion conditions in a firebox in which it is necessary to supply secondary air over the fire to give complete combustion. The induction tube is described as a simple, efficient, and effective means of supplying overfire air. In brief, the induction tube is a 2-in. vent pipe leading through the furnace or firebox wall from the outside. A $^1/_4$-in. steam pipe and nozzle is inserted within the vent pipe. The escaping steam induces air from the outside and introduces a mixture of air and steam to the firebox. Drawings and suggestions for installation are given. O.E.M.

Heat control and its transfer in high-temperature commercial kilns. ELLSWORTH PRICE OGDEN. *Refrac. Jour.*, **4** [48], 393–94 (1929); for abstract see *Ceram. Abs.*, **8** [2], 142 (1929). E.P.R.

Utilization of waste heat. ANON. *Ceram. Ind.*, **13** [4], 381–83 (1929).—The waste heat system supplies warm air for drying purposes the year around and furnishes a heating effect in the plant in cold weather (Edwin M. Knowles China Co.). The sources of waste heat are the hot air released at the relief ports and the air radiated from the crowns over the hot zones of the kilns. The heat from these various points is directed into the crown of each kiln from the firing zone to the last relief port. A large centrally

located fan takes the heat from the collecting chambers on each kiln and then distributes the warm air where needed. Having heat available from bisque and glost tunnel kilns, the heating system was divided into two parts. The system tied up with the bisque tunnel kiln furnishes warm air for drying purposes in all storerooms, casting shop, mold shop, and for heating purposes in cup shop, slip house, and raw clay storage. The system connected to the glost tunnel kiln furnishes heated air for drying saggers and dipped ware passing through the mangles; also for a heating effect in the green room, glaze room, sagger room, bisque warehouse, and glost warehouse, decorating shop, packing shed, and basement. F.P.H.

Utilization of lost heat from continuous kilns. W. BROWN. *Rev. mat. constr. trav. pub.*, No. 238, p. 156B (1929). A.J.M.

Heat economy in the brick plant. W. LEDER. *Tonind.-Ztg.*, **53** [32], 611–13 (1929).—Heat-balance data as determined for seven ring furnaces are presented. The total fuel consumption (power, furnace fuel, and drier fuel) for the seven plants was determined and found to vary considerably with the type of drier used. F.P.H.

Calculating losses due to hydrogen and to moisture in fuel. B. J. CROSS. *Combustion*, **1** [3], 52–53 (1929).—The loss is calculated by using the equation $9H_2 \times [R + 0.47\ (T_2 - T_1)] =$ B.t.u. loss. H_2 is the per cent hydrogen in the fuel, R is the latent heat of vaporization at the temperature of the ingoing air, T_2 is the flue-gas temperature, T_1 is the temperature of the ingoing air. (Temperatures are degrees F.) A chart is constructed from which the loss can be read directly. E.A.H.

Fusion point of coal ash. ANON. *Gas Age-Rec.*, **64** [14], 442 (1929).—(Review is given of the British Fuel Research Board's *Tech. Paper*, No. 23.) Considerable attention has been devoted to the development of methods for the determination of the fusibility of coal ash, and it is recognized that a classification of coals according to this property is becoming of increasing practical importance. The publication described in detail the furnaces and methods which have been evolved for the determination of (*a*) the temperature of initial deformation (softening point) and (*b*) the fusion temperature (complete fusion point) under both oxidizing and reducing conditions. Results of analysis and fusion point determinations are tabulated for specimens of ash from 10 American coals ranging from sub-bituminous coal to anthracite, and from ten representative British coals selected from various coalfields. F.P.H.

Constitution and nature of Pennsylvania anthracite, with comparisons to bituminous coal. HOMER GARFIELD TURNER. *Tech. Pub.*, No. 234 Class F, Coal and Coke, No. 26; *Mining and Met.*, **10** [274], 485 (1929).—Pennsylvania anthracite and high-rank bituminous coals are almost exactly alike in morphological constitution. Anthracite is superior to bituminous coal in toughness chiefly because of the elimination of vertical joints through metamorphic reconsolidation. The three chief components are chemically and physically different in anthracite and in bituminous coal and yet their differences are of the same order when a given component of one is compared to a like component in the other. The inorganic constituents are not combined chemically with the organic matter to any marked extent. Anthracite possesses greater adsorptive powers than does bituminous coal. The fixed ash of both is approximately 0.5%. The bulk of the ash is confined to the duller laminae from which it can be removed in part only after fine grinding, provided a mechanical method is used. F.P.H.

Burning characteristics of different coals. H. KREISINGER AND B. J. CROSS. *Fuels and Steam Power* (*A.S.M.E. Trans.*), **50** [23], 11–24 (1928).—American coals have particular burning characteristics which differ according to the geological age of the coal and its chemical composition, physical structure, moisture content, and size. The geological age is shown by C, H, and O contents. Characteristics of flame are affected by the composition of the gases rising from the fuel bed and manner in which O

is supplied for their combustion. A comparison is made of processes of combustion in the fuel bed and in powdered-coal furnaces. (*C.A.*)

Trends in the utilization of coal. M. J. CONWAY. *Blast Fur. Steel Plant*, **17** [9], 1374–75 (1929).—Coal is considered from the standpoint of economical distribution. Products resulting from its thermal decomposition are discussed with reference to fuel values. F.P.H.

Burning particles of solid fuel. GRIFFIN, SMITH, AND ADAMS. *Blast Fur. Steel Plant*, **17** [9], 1368–73 (1929).—The widespread use of powdered coal and the dearth of reliable information concerning its burning give exceptional interest to this paper. The interesting points brought out by the results are: (1) the pronounced negative temperature coefficient for the coal and semicoke as compared with the much smaller coefficient for the nonvolatile fuel, active charcoal, and probably for beehive coke, and (2) the much longer time of burning of the active charcoal as compared with the other fuels. Obvious possible explanations of the negative temperature coefficients for coal and semicoke are (1) incomplete combustion at the lower temperatures; (2) selective burning, *e.g.*, only the smaller particles burning at the lower temperatures; and (3) smaller loss of heat at the higher furnace temperatures due to smaller temperature difference between particle and furnace walls. The effect of particle size on time of burning was just as anticipated; the time decreased with a decrease in size. F.P.H.

Determinative factors in coking coal. M. BARASH. *Blast Fur. Steel Plant*, **17** [9], 1358–62 (1929).—This investigation throws considerable light on the elements in coal that affect its coking properties. F.P.H.

Practical economies from dry quenching of coke. W. SENNHAUSER. *Combustion*, **1** [3], 47–51 (1929). E.A.H.

Correlation of the physical and chemical properties of cokes, with their value in metallurgical processes. II. W. T. K. BRAUNHOLTZ, G. M. NAVE, AND H. V. A. BRISCOE. *Fuel Science Practice*, **8** [9], 411–37 (1929).—The authors find that in the determination of the volatile matter in coke not all the loss occurs in 7 min., probably not in 30 min. The "Micum" Trommel test and the shatter test are compared as methods of determining the mechanical strength of coke. The cokes made from uncompressed coals are more resistant to shatter than cokes made from stamped charges. The width of the oven seems to have no effect on the quality. The coke from the faster ovens is slightly more resistant to shatter, is heavier and less porous. Soaking lowers the shatter indices and porosities. Beehive ovens and by-product recovery ovens give practically identical cokes except for the nature of the fracture. A comparison of the use of various cokes prepared by various methods is given. E.A.H.

British report on reactivity of cokes. A. C. BLACKALL. *Gas Age-Rec.*, **64** [10], 310 (1929).—The Fuel Research Station of the Brit. Dept. of Sci. and Indus. Research is studying the rate at which coke reacts with carbon dioxide and with air. This report appears to suggest that there is some relation between the reactivity of a coke and its mechanical strength, the conditions under which it was carbonized, and the inorganic constituents it contains. F.P.H.

Heat of adsorption of oxygen on charcoal. M. J. MARSHALL AND H. E. BRAMSTON-COOK. *Jour. Amer. Chem. Soc.*, **51** [7], 2019–29 (1929). R.G.M.

International Conference on Bituminous Coal. JEAN BING. *Chaleur Ind.*, **10**, 17–25 (1929).—B. reviews in a brief manner the various papers given at the Conference which was held in Pittsburgh during November, 1928. A.J.M.

BOOKS

Transactions of the Fuel Conference, World Power Conference (London, Sept. 24 to Oct. 6, 1928). Three volumes with index volume, 177 papers including discussions

and reports, 4235 pp. Price $62.00. Percy Lund, Humphries and Co., Ltd., London; reviewed in *Gas Age-Rec.*, **64** [12], 385 (1929).—The text is principally English, 32 papers in German, and 13 papers in French. Obtainable in the U. S. from the American Committee of the World Power Conference, Washington, D. C. These transactions of the Fuel Conference represent great effort on the part of fuel experts of 48 countries. They attempt to bind together the fuel industries of the world: coal, gas, oil, electrical engineering, and chemical manufacture. The conference gave the economic aspects of the problems of primary importance; further, most of the contributions were presented through authoritative technical bodies and so came with greater force than if they had been merely individual expressions. The papers are suitably grouped into a number of separate sections, in each of which is prepared a general report embodying the more important features dealt with and outlining the main points for discussion. F.P.H.

Production and Uses of Industrial Gases. FRANZ MUHLERT AND KURT DREWS. Published by Hirzel, Leipzig. Reviewed in *Chaleur Ind.*, **10**, 49 (1929). A.J.M.

PATENTS

Annular lime kiln. EDMUND JÄNECKE. Ger. 471,920, April 12, 1927. A kiln for burning lime has compressed air admission pipes in the bottom of the burning chamber. (*C.A.*)

Annular kiln for burning lime or tile ware. EDMUND JÄNECKE. Ger. 478,631, Sept. 14, 1927. Details are given. See preceding abstract. (*C.A.*)

Protecting lower part of vertical chambers or retorts. ANON. Ger. 462,290, April 26, 1924; *Gas Age-Rec.*, **64** [11], 360 (1929).—A wet seal is used on the fire-refractory lower parts of the vertical retorts or chambers which operate periodically for the production of coal gas. The lowest part of construction, lying over the iron-supporting structure of the chamber or retort subjected to the highest temperature, is made of iron or other suitable material. This form of construction is not affected by the water that is used as a seal. F.P.H.

Gas manufacture. ALFRED AICHER. Ger. 478,459, June 27, 1925. Gas of good quality is obtained from poor fuels such as lignite by a process comprising (1) low-temperature distillation of the fuel to produce gas, tar, and semi-coke, (2) conversion of the tar oils to oil gas, (3) mixing the gases from (1) and (2) and adding water gas to the mixture, and (4) thermally decomposing the tar residues from (2) and mixing the gaseous products with the gases obtained in (3). (*C.A.*)

Generating water gas from powdered fuel. M. HELLER. Brit. 308,972, March 27, 1929. Water gas is obtained by injecting powdered fuel and steam into an externally heated chamber in which they are caused to circulate. In one form of apparatus, a series of circular reaction chambers are separated by heating chambers. Steam and fuel are supplied by peripheral tangential inlets and the water gas and ash pass out through a conduit to a steam superheater and a scrubber when the ash is removed before the gas flows to the holder. The heating compartments are each formed with peripheral air and gas conduits and the hot combustion products are exhausted through a conduit leading to a heat exchanger in which the air and gas are preheated, and then to a waste heat boiler.

Geology

Equilibrium between the carbonates and bicarbonates of sodium and potassium in aqueous solution at 25°. A. E. HALL AND S. B. SMITH. *Jour. Amer. Chem. Soc.*, **51** [6], 1626–36 (1929).—The results of an investigation are presented in which the 25° isotherm was studied for the quaternary system made up from sodium carbonate, potassium bicarbonate, and water. Figures and tables of their results are given. R.G.M.

Solubility of calcium carbonate (calcite) in certain aqueous solutions at 25°. J. L. FREAR AND J. JOHNSTON. *Jour. Amer. Chem. Soc.*, **51** [7], 2082–93 (1929).—The authors

present precise determinations of the solubility of calcite at 25° in the presence of carbon dioxide at varying pressures, in water, and in a series of solutions of sodium chloride and of calcium sulphate. R.G.M.

Solubility of magnesium carbonate (nesquehonite) in water at 25° and pressures of carbon dioxide up to one atmosphere. W. D. KLINE. *Jour. Amer. Chem. Soc.*, **51**, [7], 2093–97 (1929).—The equilibrium in solutions of magnesium carbonate at 25° was investigated over a range of pressures. Interpolated values of the molality of magnesium in the solution under these conditions are given. R.G.M.

Petroleum and petroleum products. ARTHUR KNAPP. *Mineral Ind.*, **37**, 442–72 (1928).—The world's production of petroleum in 1928 is estimated to have been 1,322,-896,000 bbl. This is an increase of 61,823,000 bbl., or 4.84% over the 1927 production. Venezuela moved into second place with a contribution of 8% displacing Russia. The output of the Western Hemisphere was 83.8% of the world total as compared to 84.8% in 1927. E.P.R.

Titanium and zirconium. F. H. DRIGGS AND J. W. MARDEN. *Mineral Ind.*, **37**, 599–606 (1928).—The demand for titanium ore and its compounds increased considerably during 1928. The two chief ores, rutile and ilmenite, constitute the principal sources of supply. Although some new uses have been suggested for titanium and its compounds the past year, the principal consumption has remained in the manufacture of pigments and ferro-alloys. The increasing importance of white titanium pigments in paints and ceramics is the result of more exacting requirements. E.P.R.

Core drilling in salt beds of western Texas and New Mexico. JAMES S. WROTH. Bur. Mines, *Information Circ.*, No. 6156, 13 pp. (1929).—The act of Congress approved June 25, 1926, authorized joint investigations by the U. S. Geol. Survey and the Bur. of Mines to determine the location, extent, and mode of occurrence of potash deposits in the U. S. This circular is confined to a discussion of the methods employed in diamond drilling and the special problems of recovering salt core, and will be limited strictly to the matter of drilling technique. R.A.H.

Consumption of tin in the U.S. during 1928. J. B. UMHAU. Bur. Mines, *Information Circ.*, No. 6165, 8 pp. (1929).—The distribution of the amount consumed by various uses, as shown in tables based on Bur. of Mines canvasses for 1927 and 1928, in comparison with consumption by uses reported by the War Industries Board for 1917. The report discusses in detail the amount of tin used by various industries. A report is also given for the first time on reclaimed or secondary tin. R.A.H.

Genesis of the crystalline magnesite deposits of the Alps. MIHALY RÓZSA. *Földtani Közlöny*, **55**, 385–86 (1926).—Magnesite, which forms large deposits in Austria, is formed by ascending magnesium hydrocarbonate-bearing solutions. The dolomite deposits have a similar origin and are formed by the action of these solutions on limestone ($CaCO_3$). (*C.A.*)

Feldspar mining in North Carolina. H. J. BRYSON. *Rock Prod.*, **32** [19], 53–56 (1929).—Feldspar occurs in pegmatite dikes. These dikes are known in more than 20 counties in the state, confined principally to the mountain district. The pegmatite belt is almost 100 miles wide and extends in a northeast-southwest direction paralleling the Blue Ridge mountains. The main feldspar belt may be divided into three smaller belts as follows: the Cowee-Black mountain belt, the Blue Ridge belt, and the Piedmont belt. The Cowee-Black mountain belt, which lies to the west of the Blue Ridge mountains, includes parts of Macon, Jackson, Transylvania, Haywood, Buncombe, Yancey, Mitchell, and Avery counties, and has produced all of the feldspar mined in this state. The chief producing district, of which Spruce Pine is the center, is confined to the last three counties. This district is about 40 miles long and 14 miles wide and is the most promising district of the south. All of the feldspar produced in this state is mined

by the open-pit method, except that produced at one underground mine, the Deer Park mine. This mine does not operate at full capacity due to the high cost of mining. The overburden on the dikes is moved by hand, drag scraper, or hydraulic methods, depending entirely on local conditions. Since most of the mines are on the hillsides, the "bench" method is used in order to give more working face in the narrow dikes. In the large mines drilling is done by compressed air drills, but in the smaller isolated mines, hand drills are employed. A correlative paper is abstracted in *Ceram. Abs.*, **8** [5], 360 (1929). F.P.H.

Opalite in northwest Arkansas. ANON. *Mfrs. Rec.*, **96** [14], 65 (1929).—Opalite, an amorphous silica, is being produced on an extensive scale in Ark. (near Rogers), by Corona Silica, Inc. The deposit runs from 10 to 85 ft. in thickness and the material as it comes from the mine is described as about 99% pure. Silica, as taken from the bed, is of chalk-like consistency, easily broken or cut, but the composition of the minute particles is so hard that ordinary methods of crushing and reducing the mass are ineffective. The product is being used in the manufacture of hard rubber, enamel, paints, etc. E.P.R.

Tripoli. P. B. BUTLER. *Refrac. Jour.*, **4** [48], 380–82 (1929).—Tripoli is an unusual form of silica found in commercial quantities only near Seneca, Mo. Similar material is found in several southern states. Tripoli is a soft, friable, porous, double-refracting form of silica of the chalcedony variety, with a fibrous structure. The average particle is less than 0.01 mm. diameter. Its analysis is about 98% silica, the remainder being largely "ignition loss." It is a form of novaculite marking the northern limits of the extensive Ark. novaculite formation. Its specific gravity has been variously reported at 2.15 to 2.41; the porosity of the crude stone is 45% and that of the powdered material from 63 to 68%. The crude stone has an absorption of 38% and the powder, 52 to 53%. It is consequently the lightest weight and most bulky, as well as the most porous and absorbent form of natural silica on the market. The history of the Seneca deposits is given. E.P.R.

Deformation and temperature. P. G. NUTTING. *Jour. Wash. Acad. Sci.*, **19** [6], 109–15 (1929).—Some of the data available on the dominant part played by molecular physics in the heat changes due to deformation are analyzed. Such deductions are drawn from the thermodynamical reasoning as seem admissible and pertinent to geological problems. This paper was prepared in connection with a discussion of the internal pressures in adsorbed films and is of geological and chemical interest. E.C.C.

Classification of important ceramic quartz-kaolinite- feldspar rocks under a practical system. A. LAUBENHEIMER. *Ber. deut. keram. Ges.*, **10** [8], 361–68 (1929).—The principal clays, feldspars, and various silica-rich materials in use in the German ceramic industry are classified by means of sections within the kaolinite–quartz–feldspar system. The rational composition of the material serves to locate the position of that substance within the system. F.P.H.

Canada's minerals and their international implications. C. K. LEITH. *Mining and Met.*, **10** [274], 463–67 (1929).—A thoughtful discussion of their present and possible future influence on international trade relations. Government has interest in development of mineral deposits. F.P.H.

New variety of clay (cimita) in Chile. ANON. *Rev. mat. constr. trav. pub.*, No. 239, pp. 181–82B (1929).—The clay has been named "cimita." It was found to consist of a nonplastic portion (mostly feldspar) and a clayey portion. The chemical composition was found to be as follows: nonplastic portion, combined SiO_2, 27.67%; Al_2O_3, 13.31; K_2O, 0.22; Na_2O, 0.15; plastic or clayey portion, SiO_2, 26.45; Al_2O_3, 21.95; Fe_2O_3, 0.40; CaO, 0.16; MgO, traces; TiO_2, 0.31; F, traces; K_2O, 3.52; Na_2O, 0.20; combined H_2O, 5.0; hygroscopic H_2O, 0.36. The mixture of clay and feldspar is sufficiently

intimate so that grinding is unnecessary. The small percentage of iron and titanium is a guaranty of a white color in the fired material. The products obtained after firing are similar to very hard stoneware with a fine-grained and well-vitrified texture. The firing temperature was about 1000°C. The plasticity of cimita is less than that of ordinary clays and this fact may cause difficulty. A.J.M.

British production of clay, etc., in 1928. ANON. *Chem. and Ind.*, **48** [31], 765–66 (1929).—The 8th Annual Report of the Secretary for Mines shows a decrease in minerals used mainly in china, pottery, and glass manufacture from 1,241,739 T. in 1927 to 1,149,859 T. in 1928. The 1928 figures are china clay 787,296 T., potters' and ball clay 188,913, china stone 61,579, limestone for glass 34,329, sand for glass 76,241, and chert in pottery trades 1510 T. H.H.S.

Yttrium in granite. J. S. VAN DER LINGEN. *Engineering*, **128**, 298 (1929).—Certain Cape (Good Hope, South Africa) granites had been supposed to contain zircon. Spectroscopic investigation showed that it was yttrium phosphate. H.H.S.

Composition and ceramic properties of the clays from the environs of the station Shdanka (Sysran-Viasma Railway). V. PERMIAKOV. *Trans. Ceram. Res. Inst.* [Moscow], No. 17, 32 pp. (1929).—The clays investigated by P. are found in the southern part of the Province of Tula (U.S.S.R.), in the environs of the station mentioned above. P. examined five varieties of clays of different color (from gray to brown); most of them were coarse grained. The clays can be used for manufacturing brick, refractory stoneware (sewers), and will act as admixture in sagger mix in the porcelain and whiteware industry. W.A.

Sands in the U.S.S.R. Investigations made in White Russia. ANON. *Monthly Information on Mineral Resources of the Geological Committee of U.S.S.R.* [Leningrad], pp. 1–32 (1929).—Deposits of quartziferous sands in the region near the city of Gomel, as well as along the river Soj, in the district Sebrovichi-Berdij were investigated in order to establish whether the amount and the quality of sands will justify the building in Novo-Belitza of a large factory equipped with up-to-date mechanical means for manufacturing window glass. According to preliminary estimation, the sand reserves of the three regions investigated are large enough to cover twice the needs of the new factory for 50 yrs. W.A.

Phosphates in Morocco. ANON. *Chem. and Ind.*, **48**, 905 (1929).—The opening of the railway line from Casablanca to Marrakech in November will develop the phosphate deposits of Morocco. Three deposits are known; it is estimated that there are 200 million metric tons of 75% $Ca_3(PO_4)_2$, while the reserves of the 60 to 65% grade are inexhaustible. Owing to the richness of these deposits, Morocco can meet all competition. H.H.S.

BOOK

Mineral Raw Materials. Trade Promotion Series, No. 76, Bur. Foreign and Domestic Commerce, Washington, D. C. J. W. FURNESS, L. M. JONES, AND F. H. BLUMENTHAL. 278 pp. Price 45 cents. For sale at U. S. Govt. Printing Office, Washington, D. C. Metals and nonmetals are surveyed by countries including the U. S., Germany, France, United Kingdom, Japan, Belgium, Italy, Spain. Part II comprises a survey by minerals, including aluminum and bauxite, antimony, chromite, copper, iron, lead, manganese ore, mercury, nickel, tin, tungsten, zinc. The following nonmetal materials are also reviewed: asbestos, barite, china clay, coal, fluorspar, graphite, gypsum, magnesite (crude), mica, nitrates (natural), petroleum, phosphates, potash, pyrites, sulphur, talc, and soapstone. The relative position as producers and consumers of the principal minerals and the percentage of world production of the materials under review by principal countries are given in tables. A brief bibliography is appended. Reviewed in *Glass Ind.*, **10** [10], 252 (1929). E.J.V.

Chemistry and Physics

Studies of $BaO \cdot Al_2O_3 \cdot SiO_2$ and $ZnO \cdot Al_2O_3 \cdot SiO_2$ separately with eutectics, KNaO feldspar eutectic, and $CaO–MgO \cdot Al_2O_3 \cdot SiO_2$ eutectic. DAVID C. ZIMMER AND JOHN M. NEFF. *Jour. Amer. Ceram. Soc.*, **12** [11], 746–49 (1929).—Because of the lack of a means for graphically representing more than four variables it was deemed best to study groups of eutectics, the uncertainties of this type of investigation being taken into consideration. The purpose of the study was to determine the deformation of certain eutectics and the effect of variations of alumina and silica on these eutectics when applied to glazes.

Influence of alumina and silica on the $(K_2O–Na_2O)Al_2O_3–SiO_2$ eutectic. W. N. BUTTERWORTH AND PAUL KATES. *Jour. Amer. Ceram. Soc.*, **12** [11], 750–52 (1929).—A series of eight studies was made on the influence of Al_2O_3 and SiO_2 on the $(K_2O–Na_2O)Al_2O_3–SiO_2$ eutectic. It was concluded that the reduction of silica lowers the deformation temperature of the $KNaO–Al_2O_3–SiO_2$ eutectic. The reduction of Al_2O_3 makes little change. The problem must be studied as a three-component series consisting of definite end members.

Studies on the alkali-aluminum-silicates: nepheline. ERHARD GRÜNER. *Z. anorg. allgem. Chem.*, **182** [3], 319–31 (1929).—These studies on the preparation of nepheline were made in a steel-pressure bomb by heating about 20 cc. $^1/_2N$ NaOH or KOH with muscovite or paragonite. Microscopical examination was made of the preparations. The lowest temperature at which nepheline was formed from such materials was 200° C. In another series of experiments kaolin and soda were used in varying proportions and heated to 1200° C. When the molecular proportion of kaolin to soda was 3:3, no soda could be dissolved by boiling water. The product is then a very fine $Al_2O_3 \cdot 2SiO_2 \cdot Na_2O$. Crystals $^1/_4$ mm. in size were grown by fusion with sodium metavanadate. When the ratio of kaolin to soda was 3:6 there was formed $Al_2O_3 \cdot 2SiO_2 \cdot 2Na_2O$, which on treatment with water gave up one molecule of soda and formed nepheline monohydrate, $Al_2O_3 \cdot 2SiO_2 \cdot Na_2O \cdot H_2O$. L.T.B.

Germanate gels of the alkaline earths. J. H. MILLER AND C. E. GULEZIAN. *Jour. Amer. Chem. Soc.*, **51** [7], 2029–42 (1929). R.G.M.

Use of a recording manometer for studying the decomposition of hydrates (particularly of alumina hydrates). L. HACKSPILL AND E. STEMPFEL. *Chimie & ind.* (Special No.), pp. 151–59 [Feb.] (1929).—*Gibbsite*, or orthoaluminic acid, $Al(OH)_3$, is irreversibly dehydrated at a perfectly definite temperature (220°). A water-vapor pressure, even of several atmospheres, can retard, but not prevent, the decomposition. This is not a dissociation phenomenon, but a sharp decomposition. Dehydration is complete and does not take place by progressive loss of H_2O with formation of lower hydrates. After it has taken place H_2O is adsorbed by the anhydrous Al_2O_3 crystals which offer a very large surface. Part of the H_2O combined as $Al_2O_3 \cdot 3H_2O$ is converted into adsorbed H_2O without having left the crystal. The adsorption is reversible as long as the adsorbing substance has not been heated sufficiently to agglomerate the small crystals and decrease the total surface. *Diaspore*, or metal-aluminic acid, $HAlO_2$, behaves like gibbsite; *i.e.*, it is dehydrated in one stage and quite sharply, but at a temperature of 500°. The presence of the intermediate hydrate $Al_2O_3 \cdot 2H_2O$ was never observed in natural products. Pure *kaolin* has a very different dehydration curve from those of the other elements of bauxite. The curve of *goethite*, $HFeO_2$, is similar to that of aluminic acids, but decomposition takes place at about 320°. These data permit determination in a single operation of the approximate composition of a natural bauxite and confirmation of the results of the mineralogical examination. (*C.A.*)

Axial ratio of alundum as obtained by the Laue spot method. SHORI TAKANI. Tohoku Imp. Univ. *Jour. Petrol., Mineral and Ore Deposits* [Japan], **1**, 71–72 (1929).—

A small alundum crystal was sectioned parallel to the axial plane and X-rays were directed upon it almost perpendicularly to axial plane. The axial ratio calculated from the pattern is $a:b:c = 0.521:1:0.954$. Kokscharo's value is therefore (0.52854 : 1 : 0.95375) more nearly correct than that given by Dana and Haumann (0.52854 : 1 : 0.4769). (*C.A.*)

Optical and thermal investigation of alundum from Naegi. SHUKUSUKE KOZU AND JUN'ICHI UEDA. *Jour. Petrol., Mineral. and Ore Deposits* [Japan], **1**, 52–60 (1929).—The alundum produced at Naegi, Gifu Prefecture (Japan), was divided into 2 groups, *A* and *B*, on the basis of their *ns*, optical axes, and double refraction. The internal *ns* of group A are, $\alpha = 1.1652$, $\beta = 1.6179$, $\gamma = 1.6249$ and are a little smaller than the external *ns*. For the *B* group the internal indices ($\alpha = 1.6148$, $\beta = 1.6174$, $\gamma = 1.6244$) are a little larger than the external. Values of 2 *V* are, for *A*, 62°20′8″ for *B*, 63°15′, from which the content of F and OH can be calculated. From the thermal data, the coefficients for the linear expansion parallel, respectively, to the *a*, *b*, *c* axes, are $l_a = 0.00044635\,t + 0.00000025\,t^2$, $l_b = 0.00035854\,t + 0.00000018\,t^2$, $l_c = 0.00059547\,t + 0.00000030\,t^2$ (*t* was measured from 20° as standard). The volume expansion calculated from these data is 0.84% at 500°, 2.08% at 1000°. From the change in weight on heating, it is shown that decomposition is most rapid at 1250 to 1300°. Sometimes fissures are formed on heating the mineral to 400°, but the cause is not very clear. It is not due to the escape of volatile matter. The change of the axial ratio on heating was also measured. (*C.A.*)

Atomic weight of antimony from different sources. R. K. MCALPINE. *Jour. Amer. Chem. Soc.*, **51** [6], 1745–50 (1929).—M. reports an investigation comparing three specimens of metallic antimony from different sources by density determinations and by titration with potassium bromate with these results: (1) the densities of the three specimens lie within 0.1 of 1% of one another. (2) The ratios of potassium bromate to antimony lie within 0.05 of 1% of each other. (3) There is no evidence of variation in the atomic weight of antimony from different sources. R.G.M.

Confirmatory test for aluminum. R. GEMMILL, R. BRACKETT, AND C. R. MCCROSKY. *Jour. Amer. Chem. Soc.*, **51** [4], 1165 (1929).—A description is given of a procedure which is identical with that published in *Jour. Amer. Chem. Soc.*, **50** [9], 2427 (1928). This method can also be used for zinc, 0.5 mg. of the metal being detected with ease. R.G.M.

Optical properties of synthetic anorthite and the results compared with those given by different methods of determining the plagioclases. L. DUPARC AND M. GYSIN. *Bull. soc. franç. minéral.*, **49**, 63–76 (1926).—A petrographic study of sections of 2 melts of theoretical composition of anorthite. (*C.A.*)

Crystal structure of barium. A. J. KING AND G. L. CLARK. *Jour. Amer. Chem. Soc.*, **51** [6], 1709–11 (1929). R.G.M.

Microchemical separation of barium and calcium. R. STREBINGER. *Mikrochemie*, **7**, 100–105 (1929).—The microchemical determination of Ba by precipitation with $(NH_4)_2Cr_2O_7$ in NH_4 acetate solution followed by collection of the precipitate in a filter tube and weighing after drying at 140° yields slightly high results, but good results are obtained if the precipitate is dissolved in dilute HNO_3, the chromic acid reduced with alcohol, and the Ba precipitated with $(NH_4)_2SO_4$. Ca is determined in the filtrate from the $BaCrO_4$ by precipitation with $(NH_4)_2C_2O_4$ and weighing as $CaC_2O_4 \cdot H_2O$ after drying at 110°. (*C.A.*)

Microchemical mineral analysis. (Detection of nickel, cobalt, copper, zinc, and cadmium.) A. MARTINI. *Mikrochemie*, **7**, 30–32 (1929).—Addition of NH_4CNS and pyridine to a neutral Co solution produces a rose-colored precipitate which becomes sky-blue and crystallizes on addition of HNO_3. An ammoniacal Cu solution to which

NH_4CNS has been added yields with pyridine green crystals of the compound $3(C_5H_5 \cdot HCNS) \cdot Cu(NH_3)_4(CNS)_2$ and with quinoline sulphate green monoclinic crystals of the compound $3(C_9H_6N \cdot HCNS) \cdot Cu(NH_3)_4(CNS)_2$. $ZnSO_4$ yields with a dilute acid solution of aniline-HCl colorless triclinic crystals of Zn aniline chloride, $C_6H_5 \cdot NH_2 \cdot HCl \cdot ZnCl_2$. Ammoniacal solutions of Cu, Ni, and Cd salts yield with NH_4CNS and aniline characteristic crystalline compounds of the type $2(C_6H_5 \cdot NH_2 \cdot HCNS) \cdot M(NH_3)_4(CNS)_2$; the Cu compound separates in green, triclinic rosets, the Ni compound in pale green, highly refracting, triclinic prisms and the Cd compound in monoclinic colorless prisms. Co solutions give a rose-colored crystalline precipitate with NH_4CNS and aniline.

(*C.A.*)

Solubility of calcium carbonate and lime in fused sodium carbonate and in fused sodium sulphate; its importance in the manufacture of glass. R. C. RAY. *Jour. Ind. Ceram. Soc.*, **1** [3], 106 (1929).—It is well known that in the manufacture of glass the use of calcium carbonate in the place of calcium oxide is more satisfactory, although one would expect a contrary result, as the chemical reaction is essentially between calcium oxide and silica in both cases. It has been found experimentally that calcium carbonate dissolves to a greater extent than calcium oxide in fused sodium carbonate. Similar results have also been obtained in the case of fused sodium sulphate, which in certain cases is used in place of sodium carbonate for the manufacture of glass. This increased solubility accounts for the better results obtained when calcium carbonate is substituted for calcium oxide. A.A.

Calcium-magnesium separation by the oxalate method. Z. HERMANN. *Z. anorg. allgem. Chem.*, **182** [4], 395–410 (1929).—In separating calcium from magnesium by the oxalate method some magnesium oxalate is precipitated with the calcium and a complete separation is not possible. Magnesium oxalate has a tendency to form supersaturated solutions. On standing, excess magnesium oxalate is precipitated; increasing temperature hastens precipitation. In the presence of calcium oxalate this precipitation is also hastened. Hence, in making separations, filtration should be made not more than an hour after the oxalate addition and also at low temperatures. It is not clear to H. whether the calcium oxalate hastens the magnesium oxalate precipitation by the formation of solid solution or by adsorption. L.T.B.

Solid solutions, isomorphism and symmorphism among oxides of bivalent metals. I. The systems: CaO–CdO, CaO–MnO, CaO–CoO, CaO–NiO, and CaO–MgO. G. NATTA AND L. PASSERINI. *Gazz. chim. ital.*, **59**, 139–43 (1929).—Bivalent metallic oxides which are crystalline in the cubic system with lattices of the NaCl type comprise a very large group of compounds, some of which differ notably both in chemical behavior and in the dimensions of their metal ions. It would therefore be expected that many of the oxides, though having identical crystalline lattice forms, would not be isomorphic in the strict definition of the term. Nevertheless it has not been known to what extent true isomorphism exists and where only simple symmorphism exists. True isomorphism exists only when mixed crystals form. In the present work, an X-ray examination (powder method) was made of 5 binary systems of CaO and other bivalent metals. The solid solutions were obtained by decomposition of solid solutions of other compounds of the metal obtained by crystallization, by fusion, or by precipitation. The simplest way was to calcine rapidly, and at temperatures not much above those required for complete dehydration or evolution of CO_2, solid solutions of the hydroxides or carbonates prepared by precipitation. The X-ray photographs of the products were compared with those of the simple oxides and mechanical mixtures of the oxides. In the system CaO–CdO, there is complete and perfect miscibility between the 2 oxides in the solid state, and, within experimental errors, the deformations of the lattice are proportional to the per cent composition. Identical solid solutions were obtained from mechanical

mixtures of the pure oxides prepared by diffusion at temperatures above 600°. In the system CaO–MnO there is only partial miscibility between the 2 oxides, which does not vary appreciably with the temperature. With the systems CaO–NiO, CaO–CdO, and CaO–MgO neither solid solutions nor compounds are formed with CaO–MgO, not even at 1500°. In general, in binary systems of CaO and other oxides with similar lattices, the solubility in the solid state diminishes rapidly with increase in the difference between the diameters of the metal ions. **II. The systems CoO–NiO, CoO–MgO, CoO–MnO, CoO–CdO, NiO–MgO, NiO–MnO, and NiO–CdO.** L. PASSERINI. *Ibid.*, 144–54.—The experiments were continued with the object of determining whether there is a quantitative relation between the solubility and the atomic dimensions. All possible binary systems among ZnO, MgO, NiO, CoO, MnO, CdO, CaO, SrO, and BaO were studied, but in the present paper only the systems CoO–NiO, CoO–MnO, CoO–CdO, NiO–MgO, NiO–MnO, and NiO–CdO are described in detail. The samples were prepared by calcination at approximately 350° of the solid solutions or of the mixtures of the corresponding hydroxides obtained by precipitation from solution of the chlorides by KOH. The powder method of X-ray examination was used as in the preceding experiments. In the systems CoO–NiO, CoO–MgO, CoO–MnO, and NiO–MgO miscibility between the oxides is complete, and the displacement of the lattice is proportional to the per cent composition. In the system NiO–MnO the solubility of the oxides was, under the conditions, only partial. In the systems CoO–CdO and NiO–CdO no solid solutions were formed, which is attributed to the great difference between the diameters of the metal ions. (*C.A.*)

Studies on the heat of fusion and the specific heat of calcium and magnesium EDWARD ZALESIŃSKI AND ROMAN ZULIŃSKI. *Bull. intern. acad. polonaise., A*, pp. 479–505 (1928) (in German).—In a specially constructed H_2O calorimeter the specific heats and the heats of fusion of solid and the average specific heats of fused Mg and Ca were determined. Differences in the specific-heat values of Ca lead to an assumption of a new allotropic modification in the neighborhood of the melting point with a smaller specific heat. Its existence was proved by measurements of the duration of crystallization of fused Ca, which recalculated according to Tamman's formula for heat of fusion gave the transition point of this modification at 800°. The specific heats (in cal./g.) of Ca for different temperature intervals are as follows: 20 to 304°, 0.1610; 20 to 504°, 0.1764; 22 to 520°, 0.1768; 20 to 697°, 0.1887; 21 to 755°, 0.1927; 22 to 785°, 0.1901 (this value obtained when coming from lower to higher temperature); 22 to 785°, 0.1724 (as obtained when coming from higher to lower temperature); 22 to 802°, 0.1724; 810° (melting point) to 930°, 0.2670. The corresponding values for Mg are: 22 to 625°, 8.2823; 650° (melting point) to 775°, 0.2880 or 0.2800. The heat of fusion in cal./g. for Ca is 78.5 (calorimeter), 74.0 (duration of crystallization); the heat of transition of the Ca allotropic modification 5.75. The values for Mg are 55.5 (calorimeter) and 46.0 (duration crystallization). (*C.A.*)

Application of methods of mechanical analysis to the study of clays and sands. O. N. BAKHVALOVA AND A. S. KORJENEVSKAIA. *Bull. du Comité Géologique* [Leningrad], **48** [1], 47–75 (1929).—A comparative evaluation of the applicability of the various methods of mechanical analysis to the study of clays and sands is discussed. The problem consisted in obtaining numerical data characterizing the mechanical composition of rocks and in separating the latter into fractions by coarseness of grain in order to subject these fractions to mineralogical examination. Various methods are mentioned. Many comparative tables are given. During the progress of the work the authors came to the decision that for the characteristic qualities of clays a separation of particles less than 0.001 mm. is necessary. The preparation of the rocks for mechanical analysis (crushing and boiling) has proved to be insufficient for all kinds of rock. In case of sands ce-

mented by lime the latter must be dissolved in 5% solution of HCl beforehand. In case of rocks containing mineral bodies easily destroyed by mechanical action the crushing process must be excluded. Three methods, those of Williams, Sabanin, and Noebel, were used especially. W.A.

Structure of cyanite. ST. NÁRAY-SZABÓ, W. H. TAYLOR, AND W. W. JACKSON. *Z. Krist.*, **71** [1–2], 117–30 (1929).—A structure is suggested for cyanite Al_2SiO_5 which is deduced from the structure determined for the closely related crystal staurolite. Both structures are based upon a cubic close-packed arrangement of oxygen atoms, and staurolite is found to consist of alternate slabs of approximate thickness, of Fe $(OH)_2$, and Al_2SiO_5. It is shown that the structure of the slab of Al_2SiO_5 in staurolite suggests a structure for cyanite which satisfies a large mass of experimental data obtained from rotating crystal photographs. The principal features of the structure are discussed. T.W.G.

Feldspar. II. ARTHUR S. WATTS. *Mineral Ind.*, **37**, 228 (1928).—Chemical analysis and physical behavior of the feldspar when fired alone are not safe guides on which to make substitutions of one feldspar for another. Small additions of quartz lower the fusion temperature of some feldspars and not of others, although the fusion behavior of the feldspars when fired alone may be practically the same. Some feldspars are rendered more fusible by the addition of small amounts of muscovite mica, while other feldspars having similar properties when fired alone are rendered distinctly less fusible. With the present satisfactory development of the feldspar mining and grinding industry, the greatest present need is for a thorough survey of the available feldspars in regard to their adaptability to use in the various branches of the ceramic industry. For Part I see *Ceram. Abs.*, **8** [4], 283 (1929). For general discussion of feldspar see abstract p. 930, these *Abstracts* (1929). E.P.R.

The system kaolin–Al_2O_3–feldspar and the system kaolin–ZrO_2–feldspar. ROBERT SCHWARZ AND ERICH REIDT. *Z. anorg. allgem. Chem.*, **182** [1], 1–18 (1929).—In these studies Zettlitz kaolin, pure Al_2O_3, and Norwegian feldspar were used. (1) Softening temperatures of a series of 60 mixtures of these materials were obtained by observing the bending of cones made from the mixtures. Temperatures were measured with a thermocouple up to 1600°C, and with a radiation pyrometer from 1600 to 2000°C. These softening temperatures are reproduced in a diagram. (2) The coefficient of expansion of various of the mixtures was then measured by means of a special dilatometer. Measurement was made at every hundred degrees from 100 to 1000° C. With increasing feldspar content the coefficient of expansion increased to a maximum of 7.3×10^{-6} for the mixture: 45% feldspar, 27.5% Al_2O_3, and 27.5% kaolin. At constant feldspar content but increasing Al_2O_3 content the coefficient of expansion increased also. (3) Some of the mixtures were fired at 1435°C and chemical resistance was determined by fusion with K_2CO_3 and Na_2CO_3 and subsequent treatment with HCl. Resistance was found to be dependent on the porosity of the sample. Feldspar rich mixtures were found to be most resistant since they were better sintered than feldspar poor mixtures. (4) These studies were made on two of the mixtures fired over a series of temperatures ranging from 1170 to 1800°C. It was found that the kaolin began to dissociate somewhere above 500°C and sillimanite began to form. The feldspar melts at about 1300° but only begins to react above 1500° to form sillimanite. At 1800°, sillimanite was the only crystalline phase remaining in the melt. (5) The study of the system kaolin–ZrO_2–feldspar was undertaken to note the effect of the replacement of Al_2O_3 by an oxide with a higher melting point. Except in ZrO_2 rich mixtures melting temperatures are lower than in the former system which is explained by the addition of a fourth component to the system Al_2O_3–SiO_2–NaKO. ZrO_2 decreases the coefficient of expansion when substituted for Al_2O_3. L.T.B.

Electric selection of kaolin. SACHIO SAITO. *Bull. Elec. Research Inst. Communications Dept.* [Japan], **220,** 1–15 (1928).—S. made a suspension of kaolin in an electrolytic solution and tried to separate and collect by cataphoresis the kaolin of different dispersities. Korean kaolin was taken and NaOH used as an electrolyte. The charge on the particle depends upon the quantity of the electrolyte in the suspension and the size of the particle, the best condition of the charge being obtained when 10 to 40% of kaolin is contained in 0.01 to 0.02 *N* NaOH. The quantity of kaolin collected by the same quantity of electricity depends upon the concentration of the mud and the current density, the current efficiency increasing with the concentration of the mud, and decreasing with the current density. A current density of 10 to 60 ma./sq. cm. was used. With a.c. superposed on d.c. the efficiency increased markedly. Temperature variations between 15 and 30° do not change efficiency. Some experiments on a semi-industrial scale are described. (*C.A.*)

Formation of acid lithium aluminate. D. PROCIV. *Collection Czechoslov. Chem. Comm.*, **1,** 95–103 (1929).—When Al dissolves in LiOH, an acid lithium aluminate is obtained. These solutions were studied by conductance and cryoscopic methods to explain the phenomenon of supersaturation. Before precipitation takes place the Al is mainly in the form of normal aluminate ions. Solubility of acid lithium aluminate determined by conductance at 25° is 1.2×10^{-4}, at 80°, 3.3×10^{-4} g. equivalent per liter. Detection and determination of Li are possible by precipitating the acid lithium aluminate by Al salt solution from solutions alkaline with NaOH or KOH. (*C.A.*)

Determination of manganese and iron by successive titration with the permanganate solution. I. S. TELETOV AND N. N. ANDRONNIKOVA. *Zhur. Prikladnoi Khim.*, **2,** 289–92 (1929).—The solution containing Fe^{+++} and Mn^{++} is treated with NaOH (12% solution) and H_2O_2 (30% solution). The precipitate is washed with water and heated in the presence of a known amount of 0.1 *N* oxalic acid solution and H_2SO_4. Mn is determined by titrating the remaining oxalic acid with *N* $KMnO_4$. The solution is then filtered through electrically reduced Cd in order to reduce Fe^{+++} to Fe^{++}. The resulting solution is again titrated with $KMnO_4$ solution for Fe^{++}. (*C.A.*)

Dilatometric analysis of some nonmetallic substances: minerals, rocks, and industrial products. A. PORTEVIN AND P. CHEVENARD. *Chimie & ind.* (Special No.), pp. 343–53 [Feb.] (1929).—Expansion curves obtained by means of the Chevenard differential recording dilatometer at various temperatures up to about 1100°, with quartz, topaz, orthite, feldspar from Saint-Yrieix, magnetite, siderite, wolframite, pyrolusite, chromite, pyrites, fused MgO, hornblende granite, mica shale from Mount Blanc, black mica granite from Calvados, basalt, fine-grained limestone (used as flux in steel making), enamel for crockery ware, refractory clay brick, and fused basalt are given and discussed. For "Dilatometric Analysis of Cast Iron," see *Ceram. Abs.*, **5** [1], 12 (1926). (*C.A.*)

Determination of small amounts of potassium in the presence of large amounts of sodium. GERHART JANDER AND HERMANN FABER. *Z. anorg. allgem. Chem.*, **181** [1], 189–92 (1929).—The method described is for the determination of potassium in the presence of sulphates, of sodium, and of magnesium. The presence of calcium salts requires a slight modification; it cannot be used in the presence of ammonium salts. It is suitable for the determination of potassium in glass, silicates, and other minerals where potassium may be present in very small amounts. The method depends on the precipitation of potassium by a solution of cobalt-sodium-nitrite in the presence of sodium chloride. The precipitate has a composition: $K_2Na_2[Co(NO_2)_6]$ aqueous, which is decomposed by a sulphuric acid solution of ferrous sulphate. Nitrogen is evolved and its volume is measured. The amount evolved is absolutely proportional to the amount of potassium present. L.T.B.

Gravimetric and colorimetric method for direct determination of sodium. E. R.

CALEY AND C. W. FOULK. *Jour. Amer. Chem. Soc.*, **51** [6], 1664–74 (1929).—A method is presented for the direct determination of sodium by precipitating it as magnesium sodium uranyl acetate. Both gravimetric and colorimetric measurements were used. R.G.M.

New qualitative reagent for sodium. E. A. CALEY. *Jour. Amer. Chem. Soc.*, **51** [7], 1965–69 (1929).—C. describes the use of a new qualititive reagent for sodium composed of a solution of uranyl and cobalt acetates in normal acetic acid. The application of this reagent in the qualitative scheme for the common metals is indicated. R.G.M.

Applications of ceric sulphate in volumetric analysis. I. Preparation and stability of solutions of ceric sulphate (containing free sulphuric acid). II. Potentiometric study of reactions between ceric and ferrous or oxalate ion. Standardization of ceric solutions. III. Potentiometric determination of cerium. N. H. FURMAN. *Jour. Amer. Chem. Soc.*, **50** [3], 755–64 (1928).—Solutions of ceric sulphate in diluted sulphuric acid are sufficiently stable to be used in volumetric analysis. It is advisable to use pure ceric oxide in their preparation and to shield the solutions from direct sunlight. The reaction between ceric and ferrous solutions is suitable for the potentiometric determination of either ion with a high order of accuracy. The reaction may be applied in the standardization of ceric solutions and in the potentiometric determination of cerium. Ceric solutions may be standardized or determined by titration with standard oxalic acid. The ceric solution must be heated. A potentiometric study of the determination of cerium has been made. Oxidation by bismuthate or persulphate followed by potentiometric titration with ferrous sulphate is a rapid and satisfactory mode of procedure. **IV. Potentiometric titration of vanadate ion alone or in the presence of ferric and chromic ions. Note on the stability of vanadyl solutions.** *Ibid.*, **50** [6], 1675–80 (1928).—The potentiometric titration of vanadyl solutions with standard ceric sulphate gives accurate results in simple solutions or in the presence of large quantities of ferric and chromic salts. The titration of mixtures of ferrous and vanadyl solutions yields correct results for both iron and vanadium. **V. Potentiometric study of the reaction between ferrocyanide and ceric ions.** N. H. FURMAN AND O. M. EVANS. *Ibid.*, **51** [4], 1128–33 (1929).—The potentiometric titration of ferrocyanide with ceric sulphate has been found to be accurate throughout a wide range of conditions and can be recommended for precise work. **VI. Oxidation of hydrogen peroxide by ceric sulphate. Indirect determination of lead.** N. H. FURMAN AND J. H. WALLACE, JR. *Ibid.*, **51** [5], 1449–53 (1929).—The direct potentiometric titration of hydrogen peroxide with ceric sulphate has been shown to be accurate in solutions moderately acidified with hydrochloric, sulphuric, nitric, or acetic acid. The reverse titration is also accurate in sulphuric and nitric acid solutions. The hydrogen peroxide-ceric sulphate reaction may be applied in the indirect determination of lead peroxide. R.G.M.

Ceric sulphate as a volumetric oxidizing agent. I. Preparation and standardization of solutions. Determination of calcium. H. H. WILLARD AND P. YOUNG. *Jour. Amer. Chem. Soc.*, **50** [5], 1322–34 (1928).—The following conclusions are reported: (1) A solution of ceric sulphate is easily prepared by dissolving in sulphuric acid CeO_2 obtained by igniting the oxalate. Pure material is not necessary as the other rare earths do not interfere in oxidation-reduction reactions. (2) This reagent is in some cases a stronger oxidizing agent than permanganate in acid solution and has a number of advantages over the latter: only one valence change is possible; it may be used in a solution containing a high concentration of hydrochloric acid and is stable toward heat. The normality factor of the solution remains constant over a long period. (3) Ceric sulphate may be accurately standardized against sodium oxalate in hot sulphuric, hydrochloric, or perchloric acid solution, the end-point being determined either electrometrically

or visually by a change from colorless to yellow. The titration of ceric salt with oxalate is quantitative in hot sulphuric, perchloric, or nitric acid solution. (4) The oxalate titration with ceric sulphate may be carried out with the same accuracy at room temperature by the use of iodine chloride as catalyst. The end-point is determined either electrometrically or with methylene blue as internal indicator. (5) Ferrous iron may be determined volumetrically in sulphuric, hydrochloric, or perchloric acid solution with ceric sulphate. The reverse titration proceeds quantitatively in a sulphuric, perchloric or nitric acid solution. (6) A method for calcium has been developed, based on precipitation as oxalate solution in hydrochloric acid, and titration with standard ceric sulphate. **II. Determination of iron.** *Ibid.*, 1334–38 (1928).—The titration of ferrous iron with ceric sulphate was investigated and the following conclusions were drawn: (1) Standard ceric sulphate may be used to titrate the iron in iron ores after a stannous chloride reduction in hydrochloric acid or a reduction with aluminum or zinc in sulphuric acid solution. (2) Arsenious acid does not interfere in the method. (3) The end-point in the titration may be determined electrometrically or with diphenylamine as internal indicator. Because of the constancy of the slight error due to oxidation of the ferrous iron by air during a titration, the ceric sulphate solution may be standardized against sodium oxalate and a very small correction factor applied, or against a standard iron ore or electrolytic iron of known purity, using the same experimental technique as employed in the analyses. **III. Titration of iodide.** *Ibid.*, 1368–71 (1928).—Iodide may be determined very accurately in a sulphuric acid solution by electrometric titration to iodine with standard ceric sulphate. The titration of ceric sulphate with iodide in sulphuric acid solution goes smoothly and may be used in determining cerium after a bismuthate oxidation. **IV. Determination of arsenic. V. Determination of antimony.** *Ibid.*, 1372–78 (1928).—Arsenious acid may be titrated accurately at 75 to 85° in hydrochloric acid solution with ceric sulphate, the end-point being determined electrometrically. Potassium bromide may be used as a catalyst in this reaction and the titration made electrometrically either at room temperature or in hot solution. Iodine has a greater catalytic effect and iodine monochloride is the most convenient form in which to use it. With this catalyst the titration is made at room temperature and the end-point determined either electrometrically or with methylene blue as an indicator. Antimony may be accurately determined by electrometric titration of antimonous chloride with ceric sulphate at room temperature, iodine monochloride being present as catalyst, and the theoretical factor being used. **VI. Volumetric determination of cerium.** *Ibid.*, 1379–85 (1928).—Cerium may be accurately determined in the presence of the other rare earths by oxidation with persulphate in the presence of silver nitrate as catalyst, followed by electrometric titration with standard ferrous sulphate, potassium iodide, or sodium nitrite. R.G.M.

Zirconium sulphate as a reagent for detection of potassium. I. R. D. Reed and J. R. Withrow. *Jour. Amer. Chem. Soc.*, **50** [6], 1515–22 (1928).—A concentrated zirconium sulphate solution detected 0.00053 g. of potassium or more, when no sodium was present. It detected 1.76 mg. of potassium when sodium was present. Zirconium sulphate when applied for a longer time is almost as delicate a test for potassium as is sodium cobaltic nitrite when the latter is applied in the usual way. To detect potassium with zirconium sulphate, add to the solution to be tested an equal volume of zirconium sulphate solution. If a deposit does not form at room temperature, cool in ice water. With small amounts of potassium a comparison with a blank is necessary. **II. Detection of potassium by zirconium sulphate in presence of ammonium ions.** *Ibid.*, **50** [11], 2985–87 (1928).—The authors have determined that the sensitiveness of zirconium sulphate for potassium in the presence of ammonium ions is 0.48 mg. or more of potassium per 2 cc. of reaction mixture. This is practically the same sensitiveness of zir-

conium sulphate for potassium when no other metal ions are present. This detection in the presence of ammonium is a distinct advantage over the other tests for potassium. **III. Influence of lithium, rubidium, cesium, and magnesium upon detection of potassium by zirconium sulphate.** *Ibid.*, **51** [4], 1062–64 (1929).—Zirconium sulphate will detect 1.0 mg. or more of potassium in 2 cc. of reaction mixture in the presence of lithium, rubidium, cesium, or magnesium ions, as well as those of sodium and ammonium. The detection of potassium by zirconium sulphate is accomplished without the use of alcohol or complicated procedure. It should always be used as the preliminary reagent, therefore, in looking for potassium, before going through the ordinary more complicated procedure. **IV. Precipitation of zirconium by phosphates.** *Ibid.*, **51** [5], 1311–15 (1929).—The efficiency of sodium phosphate, phosphoric acid, ammonium phosphate, and microcosmic salt as precipitants of zirconium has been investigated and the last three were found to be equally efficient and more efficient than sodium phosphate. Even sodium phosphate removed practically all of the zirconium. The phosphates were found most efficient in the presence of 0.344 to 0.668 *N* sulphuric acid and less efficient in the presence of 0.269 *N* nitric acid or 0.204 *N* hydrochloric acid. The investigation showed that phosphates are not efficient in removing zirconium in the absence of added acid. R.G.M.

Determination of ferrous iron in silicate rocks. II. Electrometric. B. A. SOULE. *Jour. Amer. Chem. Soc.*, **51** [7], 2117–20 (1929).—Ferrous iron can be determined quickly and accurately in magnetites and materials of higher silicate content by electrometric titration with ceric sulphate after decomposition in a Pyrex glass flask by a mixture of hydrochloric and hydrofluoric acids. Reducing agents derived from the glass have no effect. For Part I see *Ceram. Abs.*, **8** [10], 769 (1929). R.G.M.

Preparation of some metallic chromates. SAMUEL HENRY CLIFFORD BRIGGS. *Jour. Chem. Soc.*, 242–45 (1929).—B. confirms the preparation of normal chromates of Cu, Zn, Cd, by Schulze (*Z. anorg. Chem.*, **10**, 148 (1895)) and also prepared the normal chromates of Ni and Co. Methods of preparation for Zn, Zr, Al, Fe, Sb, Cu, Co, Cd, Ni, chromates, and Sb and Bi chromites given. E.C.C.

Ortho- and pyro- silicic acids. P. A. THIESSEN AND O. KOERNER. *Z. anorg. allgem. Chem.*, **182** [3], 343–50 (1929).—By slow hydrolysis of orthosilicic acid ethyl ester, an orthosilicic acid was prepared of the composition $SiO_2 \cdot 2H_2O$. On dehydration there was formed $2SiO_2 \cdot 3H_2O$ which on further dehydration formed metasilicic acid, $SiO_2 \cdot H_2O$. These definite hydrates were established from breaks in the isothermal curves of pressure-concentration diagrams. L.T.B.

Determination of the specific gravity of trass. A. STEOPE. *Tonind.-Ztg.*, **53** [32], 618–20 (1929).—The use of benzol, kerosene, or mixtures of these fluids for determining the specific gravity of trass was found to give variable results due to the adsorption of the liquids by the dry trass. F.P.H.

Bearing of base exchange on the genesis of petroleum. E. MCKENZIE TAYLOR. *Jour. Inst. Petroleum Tech.*, **14**, 825–40 (1928).—T. shows that the origin of petroleum is due to the bacterial decomposition of organic matter, probably oils and fats, under anaerobic conditions which exist under shales containing sodium clay hydrolyzed in fresh water. The original calcium clay in the presence of fresh water is converted into sodium clay. Sodium clay in water yields NaOH which neutralizes the toxic acidic products of bacterial action. The hydrolyzed sodium-clay layer is impermeable and the bacterial decomposition forms reduction products, the gases being retained under pressure. Ten Rumanian and West Indies shales were alkaline, the sodium base predominating over the calcium base clay in each case. Glycerol, the oils and fats tested, and sugar and starches under a sodium-clay layer yielded practically pure methane. (*C.A.*)

Replaceable bases in the shales and clays overlying petroliferous strata. E. Mc-

KENZIE TAYLOR. *Jour. Inst. Petroleum Tech.*, **15**, 207–10 (1929).—T. previously developed a theory (see preceding abstract) for the formation of petroleum from a study of shales and clays overlying oil-bearing sands, which postulates that Ca clays underwent base exchange when submerged in sea water, becoming Na clays; were lifted out of the sea, came in contact with fresh water, and were hydrolyzed; bacteria, working in the alkaline medium and under anaerobic conditions, broke down organic matter and the decomposition products accumulated, not being able to escape through the clay. Twenty-three samples of shales from Trinidad, Pechelbronn, and Mexico have now been examined for p_H value and replaceable bases. The p_H values and the uniform predominance of replaceable Na over replaceable Ca show that the clays have in fact undergone base exchange with NaCl and have hydrolyzed by coming in contact with fresh water. (*C.A.*)

Determination of grain size by pipette analysis. M. KÖHN. *Tonind.-Ztg.*, **53** [41], 729–31 (1929).—A specially constructed pipette is described for taking samples at various levels of a column of clay suspension. The method used for determining particle-size distribution is similar to that described by G. W. Robinson (*Jour. Agricultural Sci.*, **12**, 306 (1922)) and consists in determining the concentration of solids at various levels in a clay suspension and calculation of the particle size by means of a modified Stokes' equation. F.P.H.

Measuring plasticity and elasticity. E. C. BINGHAM AND J. W. ROBERTSON. *Kolloid.-Z.*, 1–5 (1929); *Tonind.-Ztg.*, **53** [33], 646 (1929). F.P.H.

New indicating equipment for industrial p_H measurements. H. C. PARKER. *Ind. Eng. Chem.*, **20** [7], 676–80 (1928).—Three new potentiometers are described which are suitable for making industrial H-ion measurements. Two of these have scales which are direct-reading in p_H. The technique required for making measurements with industrial types of quinhydrone and hydrogen electrodes is described. The limitations regarding the use of the quinhydrone electrode and the relative suitability of H-ion and conductivity measurements are discussed. A wiring diagram of one of the potentiometers is included and an H-ion measurement, with the quinhydrone electrode, can be made with this equipment in less than two minutes. R.G.M.

Method for differential potentiometric titration. I. D. A. MACINNES AND P. T. JONES. *Jour. Amer. Chem. Soc.*, **48** [11], 2831–36 (1926). R.G.M.

Theoretical researches on viscous liquids. C. GAUTIER. *Rev. gén. d'electricité*, (1928); *Chaleur Ind.*, **10**, 46 (1929). A.J.M.

Evaporation of liquids in still air. H. L. ROY AND T. GUPTA. *Jour. Ind. Ceram. Soc.*, **1** [3], 105–106 (1929).—The rate of evaporation of liquid per unit time per unit surface of the liquid exposed depends on the following factors: (1) difference between vapor pressure of the liquid and the partial vapor pressure of the same in air (important especially in the case of water); (2) temperature difference between liquid and the air; (3) depth of the liquid level from the top of the vessel (influence of depth varies with the area of the surface exposed); (4) barometric pressure. Results of experiments for the determination of the magnitude of the influence of the above-mentioned factors on the rate of evaporation within the range of observations are as follows: (1) Grams of water evaporated per hr. per sq. in. of surface $= \frac{\Delta p}{114}$, p in mm. of mercury. (2) Grams of water evaporated per hr. per sq. in. of surface $= \frac{\Delta T}{120}$, T in °F. (3) Rate of evaporation decreases with the lowering of the liquid-level from the top of the vessel. It has not yet been possible to find a mathematical expression for this effect. (5) Until now all experiments have been carried out at almost the same barometric pressure. Further work on the same and with liquids other than water are in progress. A.A.

Mathematical criticism of measurements in methods of ceramic research. VLADIMIR SKOLA. *Feuerfest*, **5** [8], 137–39 (1929).—In ceramic research there are two methods of measurement: (1) exact measurement such as chemical analysis where absolute amounts of materials are determined; (2) statistical measurement such as the measurement of tensile strength, where one measurement may not give a true value. In such methods several measurements are made and an average taken. Thus in two series of brick *A* and *B*, six individual measurements are made. The average tensile strength of *A* may be less then that of *B*, but the individual measurements of *A* may vary over a greater range than those of series *B*. Some consideration should be given such variation in strength in the final analysis of the results. This is done by a development of the method of the "least squares" from which he derives a value "*m*," the error of the arithmetical mean, which depends on the variation of the individual measurements of a series and which gives a critical method for examining the exactness of the results.

L.T.B.

Thermoelectric temperature scales. WM. F. ROESER. Bur. Stand., *Jour. Research*, **3** [3], 343–57 (1929).—The international temperature scale, adopted in 1927 by the 7th General Conference of Weights and Measures representing 31 nations, is the 4th thermoelectric temperature scale used by the Bureau of Standards since 1912. In putting this scale into use it was necessary for the Bureau to replace all of the fixed points used previously to 1926 by new fixed points specified in the International Temperature Scale. It is the purpose of this work to determine how much change this has caused in the temperature scale and to make available comparisons between the various scales used by the Bureau of Standards since 1912. The difference between 4 thermoelectric temperature scales based upon (1) antimony, silver, and gold; (2) zinc, antimony, silver, and gold; (3) zinc, aluminum, and copper; (4) zinc, antimony, and copper as calibration points have been determined. The maximum difference between (1) and (2) was found to be 0.1°C, between (1) and (3) 0.2°C, and between (1) and (4) 0.3°C, in the temperature range 660 to 1063°C. The freezing point of the copper silver eutectic alloy, 71.9% silver, and 28.1% copper, on the International Temperature Scale was found to be 779.4°C ± 0.1°C. The difference between the freezing points of gold and copper was found to be 20.0°C ± 0.1°C. Methods used at the Bureau in realizing the International Temperature Scale in the range 660 to 1063°C are described in detail.

R.A.H.

Chromium oxide and its employment in the ceramic industries. P. RENAULT. *Corriere ceram.*, **10**, 133, 135, 137 (1929).—A review. (*C.A.*)

Geophysical Abstracts. IV. FREDERICK W. LEE. Bur. Mines, *Information Circ.*, No. 6164, 26 pp. (1929).—In continuation of circulars previously issued this report gives discussion of various experts in their particular fields on geophysical prospecting by gravitational, magnetic, seismic, electrical, radioactive, geothermal and unclassified methods. For Part III see *Ceram. Abs.*, **8** [11], 839 (1929). R.A.H.

Radiography as a tool in the industry. W. L. FINK AND R. S. ARCHER. *Trans. Amer. Soc. Steel Treating*, **16** [4], 551–99 (1929).—Radiography has now been successfully employed in regular commercial operations for nearly two years at the Cleveland plants of the U. S. Aluminum Co. Typical examples of the applications which have been made of the radiographic method in this laboratory are given. The cost of these radiographs is given and the field of profitable application of the method is discussed. There are also brief descriptions of methods and apparatus. A comprehensive bibliography is appended. E.P.R.

BOOK

Determination of the Properties of Clays. ERNST BUSS. Published by Tonind.-Ztg., Berlin; reviewed in *Rev. mat. constr. trav. pub.*, No. 229, p. 240B (1928). A.J.M.

PATENT

Alkali-metal compound of a sub-oxide of titanium and derivatives therefrom. FOORD VON BICHOWSKY. U. S. 1,731,364, Oct. 15, 1929. (1) As new chemical compounds the alkali metal compounds of the sub-oxide of titanium (Ti_3O_5), comprising dense-colored substance insoluble in water. (2) The ortho-compounds derived from the alkali metal compounds of the sub-oxide of titanium (Ti_3O_5).

General

Relation of state university experiment stations to national organizations in product research. MILO S. KETCHUM. *Bull Amer. Ceram. Soc.*, **8** [10], 299–302 (1929).—After a brief discussion of the beginning of engineering experiment stations, starting with that at the University of Illinois in 1903 and continuing until there are now thirty-six in the land-grant institutions, K. takes up the types of investigations carried on at the stations. Citations of the appreciation of engineering experiment station research are given. Industrial coöperation and the training of men for the industry are discussed. Ceramic investigations being carried on at the Illinois Station are enumerated. E.J.V.

Reports on Ohio and Pennsylvania clays. ANON. *Brick Clay Rec.*, **75** [8], 478–79 (1929).—Discussions of various technical questions affecting the refractories industry featured at the mid-season meeting of the Refractories Division of the AMERICAN CERAMIC SOCIETY and the American Refractories Institute at Columbus, Ohio, Sept. 24. For list of papers see *Bull. Amer. Ceram. Soc.*, **8** [9], 297 (1929). E.J.V.

Character of shrinkage and deformation of ceramic bodies. LUDWIG HEIN. *Keramos*, **8** [9], 301–305 (1929).—H. discusses fundamentally the factors affecting shrinkage of ceramic bodies. These factors are (1) treatment of body in plastic state such as pugging and wedging, (2) placing of the ware in the kiln, or position of ware with respect of other ware, and (3) design or shape of ware. A method of determining the shrinkage of ware is described in detail. The body to be tested should be placed in the kiln on a body of similar composition but separated from it by means of a thin layer of dry clay. This method eliminates the "dragging" of one body over the other as the two bodies have the same shrinkage characteristics. The shrinkage should be determined for the three dimensions of the cube and on its diagonals. F.P.H.

Experimental oil-shale plant of the Bureau of Mines. M. J. GAVIN. *Ind. Eng. Chem.*, **20** [8], 784–91 (1928).—A description is given of the experimental oil-shale plant operated by the U. S. Bureau of Mines at Rulison, Colo. The oil-producing equipment consists of two retorts, a standard Pumpherston retort of the type in commercial use in Scotland and a N-T-U retort as used in California. Analyses of the oils produced by both retorts are given. The results obtained thus far have demonstrated the utility of both retorts as large-scale units and future work will make the process more suitable to American shales. R.G.M.

Shale-mining methods reduced to a minimum by mechanical methods. J. B. NEALEY. *Mining and Met.*, **10** [274], 458–59 (1929).—The common method of shale mining, drilling, shooting, and steam-shovel loading, is fast giving place to the shale planer. F.P.H.

Greater world borax consumption increases American exports. H. O. MORAW. *Commerce Repts.*, **39**, 845–47 (1929).—In 1914, the U.S. produced about 46% of the total world's supply of crude borate minerals, with Chile next with about 36%. The output of the U.S. grew rapidly during the war while the supplies from the other countries were greatly reduced. In 1903, the U. S. production of crude borax minerals was 34,430 T. By 1914, it had grown to 62,400 short tons, while the sodium borate output in 1914 was 26,501 short tons. The year of maximum production of crude borax

minerals was 1923 (136,650 T.), and of borax (64,864 T.). Notwithstanding the position of the U. S. as a source of borax, crude borax minerals are imported to the extent of nearly 8000 T. with small quantities of refined borax. The present rate of consumption of boron compounds and borax in the U.S. is 40,000 to 50,000 T. annually. These materials have a wide range of use, the largest of which is in the pottery and enamel industries for glazes. Estimates are that half of the boron compounds consumed find an outlet for this purpose. Another use is in the manufacture of glass, where both borax and boric acid are used. Borax is used in the manufacture of heat-resisting glassware, in the form of baking dishes of all kinds, beakers, flasks, tubing, and similar articles in the laboratory. The former is known as borosilicate glass, with a low coefficient of expansion which gives it the property of being but slightly susceptible to changes of temperature. This form is used largely in incandescent lamps and chimneys. For the laboratory glass it must have the same heat-resisting property and for many purposes besides it must be acid resisting. The extensive production of this type of glass in the U. S. during the last 10 or 12 years was probably one of the principal factors in the increased domestic consumption of borax. The consuming industries in foreign countries are enumerated. E.J.V.

Feldspar. FELDSPAR GRINDERS' INSTITUTE. ANON. *Glass Ind.*, **10** [10], 247–48 (1929); *Rock Prod.*, **32** [20], 107 (1929); *Amer. Glass Rev.*, **48** [52], 15 (1929).—A general discussion of the character, uses, and properties of feldspars is given. Some of the states which contain the principal deposits of feldspar are enumerated. While the uses are greatly diversified, feldspar is indispensable in the manufacture of sanitary, electrical chemical, and medical articles as well as a great number of glass products. The particular properties feldspar imparts to glass are enumerated. Methods used in mining and further preparing feldspar for the trade are discussed. This discussion was presented at the convention of the Feldspar Grinders' Institute held at Atlantic City, Sept., 1929. See also abstract on feldspar, p. 922, these *Abstracts*. E.J.V.

Elimination of waste. ANON. *Abrasive Ind.*, **10** [10], 37–38 (1929).—Chas. W. Lytle, chairman of the Elimination-of-Waste Committee of the A.S.M.E., outlined the successful 1929 April campaign in which several hundred concerns actively participated. E.P.R.

Sale of clays in 1928. ANON. *Clay-Worker*, **92** [3], 215 (1929); *Brick Clay Rec.*, **75** [7], 414 (1929).—Comparative figures on the sale of clays as clay or mined under royalty for the years 1927 and 1928 are as follows:

	1927		1928	
	Short tons	Value	Short tons	Value
Kaolin	454,245	$ 3,809,834	496,142	$4,088,003
Ball clay	119,763	913,976	120,878	984,075
Slip clay	6,137	32,264	5,699	30,796
Fire clay	2,699,761	7,719,725	2,785,158	7,480,609
Stoneware clay	98,355	203,648	95,626	207,275
Miscellaneous clay	470,915	1,017,712	522,829	1,409,981
	3,849,176	$13,697,159	4,026,332	$14,200,739

Imports of clay decreased in quantity but increased in value in 1928 as compared with 1927. The imports of clay amounted to 370,379 short tons, valued at $3,506,363, a decrease of 6% in quantity but an increase of nearly 2% in value. Kaolin or china clay constituted 83% of the total imports in 1928. E.J.V.

Sales of clay in 1928 increased. ANON. *Amer. Glass Rev.*, **49** [1], 36 (1929).—The quantity of clay sold by producers in the U.S. in 1928 amounted to 4,026,332 short tons, valued at $14,200,739 or $3.53 per ton. These figures show an increase of 5% in quantity and 4% in value compared with 1927. They represent only clay sold as clay or

mined under royalty and do not include the much greater quantity of clay that was fired into clay products by the producers themselves from their own property. E.P.R.

Submerged combustion for industrial use in Britain. C. H. S. TUPHOLME. *Gas Age-Rec.*, **64** [12], 373–74 (1929).—Submerged Combustion, Ltd. (Westminster), has developed submerged combustion to wide commercial application and reliability. One of the primary advantages of burning fuel in complete direct contact with a liquid to be heated is the intensely intimate contact of the heat with the fluid and the elimination of the heat loss in interposed boiler shells, tubes, or containers. A mixing chamber provides very intimate mixing in correct proportions, avoiding stratification which ordinarily occurs. The mixture is then led through a high-velocity passage (which effectively prevents back-firing) and passes to the combustion chamber. The refractory lining attains high incandescence and insures instant and perfect combustion of the injected mixture. F.P.H.

Cracking during the drying of ceramic products. ANON. *Rev. mat. constr. trav. pub.*, No. 239, pp. 165–68B (1929). A.J.M.

What happens when clay is fired? A. T. GREEN. *Claycraft*, **1**, 334–38 (1928); *Bldg. Sci. Abs.* [N. S.], **1**, 235; for abstract see *Ceram. Abs.*, **8** [8], 598 (1929). (*C.A.*)

LePage's cement mends broken glass. ANON. *Nat. Glass Budget*, **45** [20], 5 (1929).—Broken glassware, china, marble, metal, and many other materials when broken can be repaired with LePage's waterproof cement. E.P.R.

Silicosis with low incidence of tuberculosis. E. R. HAYHURST, D. J. KINDEL, B. E. NEISWANDER, AND C. D. BARRETT. *Jour. Ind. Hyg.*, **11**, 228–44 (1929).—A sandstone quarry district in northern Ohio showed 28.5% silicosis among the 919 workmen employed with only 1.9% tuberculosis, the usual ratio of T.B. to S.C. being 20 to 30%. This anomaly is ascribed to the nature of the rock, which consists of obtuse (rather than acute) angled crystals of SiO_2 held together by kaolin-forming substances and sulphide and oxide of Fe. It is suggested that other silicosis studies should include rock analysis. H.H.S.

Methods, costs, and safety in stripping and mining coal, copper ore, iron ore, bauxite, and pebble phosphate. F. E. CASH AND M. W. VON BERNEWITZ. *Bur. Mines, Bull.*, No. 298, 275 pp. (1929).—Discussions and detail descriptions are given of various types of machinery employed in stripping and mining as well as transportation equipment. Type of mining and cost are also discussed. R.A.H.

Simple cost system. ANON. *Brick Clay Rec.*, **75** [7], 416–17 (1929).—A brief discussion of an efficient cost-recording system used by the Royalton Face Brick Co. (Middletown, Pa.). The two forms used in the system are pictured and their use explained. E.J.V.

Distribution of power costs. J. J. BERLINER. *Blast Fur. Steel Plant*, **17** [9], 1376–78 (1929).—Several methods for apportioning costs are mentioned and their fitness under different conditions is explained. F.P.H.

Scientific methods in the ceramic industry. ANON. *Rev. mat. constr. trav. pub.*, No. 237, pp. 128–29B (1929). A.J.M.

Mechandise marks for exports to Britain. H. M. BOARD OF TRADE. *Chem. and Ind.*, **48**, 861 (1929); for abstract see *Ceram. Abs.*, **12** [6], 461 (1929). H.H.S.

Engineering and human values. RALPH E. FLANDERS. *Mech. Eng.*, **51** [9], 649–52 (1929). E.A.H.

Duties of a chief executive in a business of moderate size. WM. L. BATT. *Mech. Eng.*, **51** [9], 682–84 (1929).—B. visualizes the duties of the chief executive of a modern corporation as (1) creation of an effective operating staff, which involves allocation of junior executive responsibility and maintenance of esprit de corps, (2) correlation of

income and disbursement, (3) determination of major policies and study of trend of development of the business both in relation to competition and to general conditions. E.A.H.

Management responsibility. F. A. KIRKPATRICK. *Brick Clay Rec.*, **75** [7], 420–21 (1929). E.J.V.

Fundamentals of the psychotechnical examinations. E. KILLIAS. *Keramos*, **8** [16], 583–90 (1929).—A discussion is given of the psychotechnical examinations as outlined by Dr. Moede of the Institute for Industrial Psychotechnology. F.P.H.

Future of chemical societies and chemical literature. L. E. WESTMAN. *Chem. and Ind.*, **48**, 859–60 (1929).—The cost of technical abstracts should be borne by the Government, thereby releasing societies to do valuable work now neglected. H.H.S.

Writing of technical papers. W. L. DEBAUFRE. *Combustion*, **1** [3], 29–34 (1929).—D. discusses the subject under the headings: title, introduction, conclusions, summary, body of paper, appendices, references, illustrations, paragraphs, sentences, words, abbreviations, symbols, capitals, italics, punctuation, books on subject, and preparation of material. E.A.H.

Technical classes for pottery and glass. ANON. *Pottery Gaz.*, **54** [628], 1595 (1929).—A few details about classes of a technical nature at Staffordshire, Sheffield, and in London are given. E.J.V.

Christian Carstens. ANON. *Keramos*, **8** [16], 581 (1929).—A biography is given. F.P.H.

Battelle Memorial Institute. H. W. GILLETT. *Mining and Met.*, **10** [274], 472–74 (1929).—Battelle Memorial Institute (Columbus, Ohio) is an endowed institution for scientific research in metallurgy, fuels, and allied fields, established by the will of Gordon Battelle, 2nd, as a memorial to his father, Colonel John Gordon Battelle. F.P.H.

Fostoria glass. ALDEN WELLES. *Crockery and Glass Jour.*, **107** [9], 24–27 (1929).—The history of the Fostoria Glass Co. (Moundsville, W. Va.), together with a detailed description of some of the outstanding ware produced by the company is given. A feature of interest is that the present location of the plant takes its name from an enormous mound of earth built by a primitive race of Indians and in which a quantity of porcelain beads and other articles were found. E.P.R.

A.S.M.E. to celebrate Fiftieth Anniversary. ANON. *Abrasive Ind.*, **10** [10], 47 (1929); see *Bull. Amer. Ceram. Soc.*, **8** [10], 325 (1929). E.P.R.

American Iron and Steel Institute meeting. ANON. *Engineering*, **128**, 249–50 (1929).—Summaries of the seven papers presented at meeting held in New York, 1929. To ceramists the most interesting were R. B. Sosman's "Silica as a refractory in the steel industry" and S. W. Parr's "Illinois coals." H.H.S.

Tenth convention of the German Ceramic Society. ANON. *Ber. deut. keram. Ges.*, **10** [8], 372–80 (1929).—The convention was held at Heidelberg, Sept. 27–30, 1929. F.P.H.

Progress in the ceramic industry in England during the years 1927–1928. W. STEGER. *Feuerfest*, **5** [8], 133–36 (1929). L.T.B.

Economic condition of the Czechoslovakian ceramic industry in 1928. CARL H. PETERS. *Feuerfest*, **5** [8], 139–40 (1929).—There was a slight increase in the value of the exports of the country in 1928 over that of 1927. Cost of production was lowered during the year. L.T.B.

Italian ceramic industry in 1928. ANON. *Rev. mat. constr. trav. pub.*, No. 238, pp. 162–63B (1929). A.J.M.

Résumé of the glass and enamel industry. ANON. *Glashütte*, **59** [35], 629–30 (1929).—Economic review of the German industries for the first half of 1929. L.T.B.

Lignite power stations in Germany. DAVID BROWNLIE. *Combustion*, **1** [3], 25–28 (1929).—Germany consumes 80% of the world's output of lignite. E.A.H.

Importation of ceramic materials into Russia during 1928. CARL H. PETERS. *Feuerfest*, **5** [8], 140 (1929).—The value of the ceramic materials imported into Russia was 2.19% higher in 1928 than in 1927. L.T.B.

Ceramic industry in Latvia. ANON. *Rev. mat. constr. trav. pub.*, No. 232, p. 21B (1929). A.J.M.

Present position of the ceramic industries of India. S. DEB. *Jour. Ind. Ceram. Soc.*, **1** [4], 119–40 (1929).—In the presidential address, D. describes in detail the present status of ceramic industries in India. Of the large quantities of ceramic goods imported mainly from Europe and Japan, import of glass makes up 99% of the total. The manufacture of Portland cement has increased very considerably in recent years; the reasons for its rapid expansion together with the principal cement factories are given. Some of the steps proposed in the development of ceramic industries are as follows: (1) A proper survey of ceramic materials to be made in every province in India and their economic value ascertained. (2) A central research laboratory and information bureau with a commercial museum, to carry on researches in different branches of the ceramic industry with indigenous raw materials and to place the results of such researches at the disposal of interested financiers and industrialists who are already in the line; also a library attached to the laboratory with all the books on the subject. (3) To move the Government for the revision of railway rates on raw materials and finished products which are excessive. (4) Tariff protection. A.A.

BOOKS

Comparative Study of Engineering Education in the U.S. and Europe. WILLIAM E. WEIKENDEN. Society for the Promotion of Engineering Education, N. Y., 1929. 275 pp. illus. 40 cents; reviewed in *Mining and Met.*, **10** [274], 34 (1929).—Most of this valuable and important work is given over to a concise and critical description of European equipment and procedure in engineering education together with an account of its influence on the development of institutions and courses in the U.S. F.P.H.

Mechanical World Electrical Pocket Book. 326 pp., published by Emmott & Co., Ltd.; reviewed in *Abrasive Ind.*, **10** [10], 52 (1929).—This is an annual publication of electrical information in handy form for ready reference. E.P.R.

American Lubrication. L. B. LOCKHART. 3rd ed. 392 pp. The Chemical Publishing Co., Easton, Pa., $5.00. Nearly three-fourths of the test relates to specifications, physical and chemical tests. These are given in complete detail and constitute a good reference on the subject. Specifications quoted have been taken from those used by large buyers. Reviewed in *Can. Chem. Met.*, **13** [9], 52 (1929). E.J.V.

Theory, Calculations, and Construction of Industrial Chimneys and Stacks. E. LAFON. 176 pp. Published by Beranger, Paris.—Empirical formulas, principles, various theories, a new formula, the height of stacks, static calculations, and construction are treated. Reviewed in *Chaleur Ind.*, **10**, 48 (1929). A.J.M.

Annuaire des Céramistes et Verriers de France. J. HOGREL. *Céramique et Verrerie*, Paris. This directory gives the names and addresses of French pottery and glass manufacturers, classified in groups. In addition to the directory section there is a list of trade marks. Reviewed in *Rev. mat. constr. trav. pub.*, No. 235, p. 95B (1929); *Pottery Gaz.*, **54** [628], 1620 (1929). A.J.M.

Yearbook of the French Ceramists and Glassmakers. 1929 Edition. Published by Céramique et Verrerie, Paris; reviewed in *Rev. mat. constr. trav. pub.*, No. 235, p. 95B (1929). A.J.M.

Yearbook of the Syndicate of Manufacturers of Ceramic Products in France. Reviewed in *Rev. mat. constr. trav. pub.*, No. 236, p. 119B (1929). A.J.M.

LIST OF CERAMIC PUBLICATIONS

This list of Ceramic Periodicals is issued annually to assist the readers of *Ceramic Abstracts* in locating references for articles which have been published throughout the year.

The name of the journal is set in bold face type and the standard abbreviation follows in parentheses and italics.

Ceramic Abstracts wishes to acknowledge the assistance given by Mrs. Nellie G. Mahaffey of *Chemical Abstracts* in the preparation of this list.

Abrasive Industry (*Abrasive Ind.*), Penton Publishing Co., Penton Building, Cleveland, Ohio.

Allgemeine Glas- und Keram.-Industrie (*Allgemeine Glas- Keram.-Ind.*), T. F. Rimpler, Haida, Germany.

American Architect and Architectural Review (*Amer. Architect Architectural Rev.*), 239 W. 39th St., New York, N. Y.

American Association of Textile Chemists and Colorists (*Amer. Assn. Textile Chemists Colorists*), Howes Publishing Co., 90 William St., New York, N. Y.

American Ceramic Society. *See* Bulletin of the American Ceramic Society; Ceramic Abstracts; Journal of the American Ceramic Society.

American Chemical Society. *See* Chemical Abstracts; Industrial and Engineering Chemistry; Journal of the American Chemical Society.

American Concrete Institute. *See* Proceedings of the American Concrete Institute.

American Dyestuff Reporter (*Amer. Dyestuff Reporter*), Howes Publishing Co., 90 William St., New York, N. Y.

American Electrochemical Society. *See* Transactions of the American Electrochemical Society.

American Enameler (*Amer. Enameler*), Porcelain Enamel & Manufacturing Co., Franklin St., at Calvert, Baltimore, Md.

American Foundrymen's Association. *See* Transactions of the American Foundrymen's Association.

American Glass Review (*Amer. Glass Rev.*), Commoner Publishing Co., Box 555, Pittsburgh, Pa.

American Institute of Chemical Engineering. *See* Transactions of the American Institute of Chemical Engineering.

American Institute of Electrical Engineers. *See* Journal of the American Institute of Electrical Engineers.

American Institute of Mining and Metallurgical Engineers. *See* Mining and Metallurgy; Transactions of the American Institute of Mining and Metallurgical Engineers.

American Iron and Steel Institute, Year Book (*Amer. Iron Steel Inst. Year Book*), 40 Rector St., New York, N. Y.

American Journal of Science (*Amer. Jour. Sci.*), New Haven, Conn.

American Machinist (*Amer. Machinist*), McGraw-Hill Co., Inc., 10th Ave. at 36th St., New York, N. Y.

American Magazine of Art (*Amer. Mag. Art*), American Federation of Arts, 1741 New York Ave., New York, N. Y.

American Mineralogist (*Amer. Mineralogist*), Alexander H. Phillips, Princeton University, Princeton, N. J.

American Physical Society. *See* Bulletins of the American Physical Society; Reports of the Education Committee of the American Physical Society.

American Refractories Institute, Technical Bulletin (Amer. Refrac. Inst., *Tech. Bull.*), 2218 Oliver Bldg., Pittsburgh, Pa.

American Society of Mechanical Engineers. *See* Mechanical Engineering; Transactions of the American Society of Mechanical Engineers.

American Society for Steel Treating. *See* Transactions of the American Society for Steel Treating.

American Society for Testing Materials. *See* Proceedings of the American Society for Testing Materials.

American Zinc Institute. *See* Bulletin of the American Zinc Institute.

Analele minerlor din România, Str. Lascar Calargiu 17, Bucharest, Roumania.

Anales de la sociedad española de física y química (*Anales soc. españ. fís. quím.*), Real Sociedad Española de Física y Química, San Bernado, 49 (Universidad) Madrid (8) Spain.

Analyst, W. Heffer and Sons, Ltd., Cambridge, England.
Annalen der Physik (*Ann. Physik*), Johann Ambrosius Barth, Dorrienstr. 16, Leipzig, Germany.
Annales Academiae scientiarum Fennicae (*Ann. Acad. sci. Fenn.*), Suomalaisen Tiedeakatemian Kustantama, Helsingfors, Finland.
Annales institut d'analyse physico-chimique [Leningrad] (*Ann. inst. anal. phys.-chim.* [Leningrad]), Leningrad, U.S.S.R.
Annales des ponts. et chaussées (*Ann. ponts. chauss.*), A. Dumas, 6 rue de la Chaussée-d'Antin, Paris, France.
Annales société géologique de Belgique (*Ann. soc. géol. Belg.*), Vaillant-Carmanne, Place St. Michel 4, Liège, Belgium.
Annali di chimica applicata (*Ann. chim. applicata*), Via S. Paolo 10, Milano 103, Italy.
Annual Report of the Chemical Society (*Annual Rept. Chem. Soc.*), Chemical Society, Gurney and Jackson, 33 Paternoster Row, London, E.C. 4, England.
Apotheker Zeitung (*Apoth. Ztg.*), Deutsche Apotheker Verein, Levetzowstr. 16B, Berlin, N. W., Germany.
Architect, Forbes Publishing Co., Inc., 101 Park Ave., New York, N. Y.
Architectural Forum (*Arch. Forum*), Rogers & Manson Co., 383 Madison Ave., New York, N. Y.
Architectural Record (*Arch. Rec.*), S. W. Dodge Corp., 115 West 40th St., New York, N. Y.
Architecture, Charles Scribner's Sons, 5th Ave. at 48th St., New York, N. Y.
Architecture and Building (*Arch. & Bldg.*), Wm. T. Comstock Co., 23 Warren St., New York, N. Y.
Archiv für das Eisenhüttenwesen (*Arch. Eisenhüttenwesen*), Verlag Stahleisen m.b.H., Breitestr. 27, Düsseldorf, Germany.
Archiv für elektrotechnik (*Arch. elektrotech.*), Julius Springer, Linkstr. 23–24, Berlin, W. 9, Germany.
Archiv für Wärmewirtschaft und Dampfkesselwesen (*Arch. Wärmewirt.*), Verein Deutscher Ingenieure Verlag, Berlin, Germany.
Archives of Chemistry and Pharmacy (*Archives Chem. Pharm.*), Zagreb, Mazuranicev trg. 29, Jugoslavia.
Arkiv za Hemiju i Farmaciju. *See* Archives of Chemistry and Pharmacy.
Art and Archaeology, The Octogen Annex, Washington, D. C.
Art et decoration, Rue de l'Échelle 2, Paris, France.
Arts and Decoration (*Arts and Dec.*), 45 W. 45th St., New York, N. Y.
Arts et Métiers, 15 Blvd. St. Martin, Paris, France.
Asbestos, Secretarial Service, 1701 Winter St., Philadelphia, Pa.
Asia, 468 Fourth Ave., New York, N. Y.
Association de Documentation. *See* Bulletin de l'Association de Documentation.
Association of Official Agricultural Chemists. *See* Journal of the Association of Official Agricultural Chemists.
Atlantis Monthly Illustrated, Atlantis, Inc., 19 W. Forty-Fourth St., New York, N. Y.
Atti del congresso nazionale di chimica pura ed applicata (*Atti congresso naz. chim. pura applicata*), Associazione italiana di chimica generale ed applicata, Via 4 Novembre 154, Rome, Italy.
Atti della reale accademia nazionale die Lincei (*Atti accad. Lincei*), Dott. Giovanni Bardi, Tipografia della r. accademia nazionale die Lincei, Rome, Italy.
Australasian Institute of Mining & Metallurgy. *See* Proceedings of the Australasian Institute of Mining & Metallurgy.
Australia Institute of Science & Industry. *See* Bulletins of the Australia Institute of Science & Industry.

Baumarkt, Uferstr. 21, Leipzig, C. 1, Germany.
Berichte der deutschen chemischen Gesellschaft (*Ber. deut. chem. Ges.*), Deutschen chemischen Gesellschaft, Sigismundstr. 4, Berlin, W. 10, Germany.
Berichte der deutschen keramischen Gesellschaft (*Ber. deut. keram. Ges.*), Ringbahnstr. 10, Berlin-Halensee, Germany.
Berichte der Fachausschüsse des Vereins deutschen Eisenhüttenleute, Breitestr. 27, Düsseldorf, Germany.
Berichte der Werkstoffauschüss des Vereins deutschen Eisenhüttenleute, Breitestr. 27, Düsseldorf, Germany.
Beton und Eisen (*Beton Eisen*), Wilhelm Ernst & Sohn, Wilhelmstr. 90 Berlin, W. 66, Germany.

Biedermann's Zentralblatt (*Biedermann's Zentr.*), Akademische Verlagsgesellschaft m.b.H., Leipzig, Germany.
Black Hills Engineer (*Black Hills Eng.*), The South Dakota State School of Mines, Rapid City, South Dakota.
Blast Furnace and Steel Plant (*Blast Fur. Steel Plant*), Steel Publications Inc., Thaw Bldg., 108 Smithfield St., Pittsburgh, Pa.
Brass World. *See* Brass World and Platers' Guide.
Brass World and Platers' Guide, Brass World Publishing Co., 153 Waverly Place, New York, N. Y.
Braunkohle, Wilhelm Knapp, Mühlweg 19, Halle (Saale), Germany.
Brennstoff-Chemie (*Brennstoff-Chem.*), Verlag von W. Girardet, Essen, Germany.
Brennstoff- und Wärmewirtschaft (*Brennstoff-Wärmewirt.*), Wilhelm Knapp, Mühlweg 19, Halle (Saale), Germany.
Brick and Clay Record (*Brick Clay Rec.*), Industrial Publications, Inc., 407 S. Dearborn St., Chicago, Ill.
British Association of Chemists (*Brit. Assn. Chemists*), Empire House, 175 Piccadilly, London, W. 1, England.
British Cast Iron Research Association. *See* Bulletin of the British Cast Iron Research Association.
British Chemical Abstracts (*Brit. Chem. Abs.*), Central House, 46–47 Finsbury Sq., London, E.C. 2, England.
British Clayworker (*Brit. Clayworker*), 43 Essex St., Strand, London, W.C. 2, England.
British Dental Journal (*Brit. Dental Jour.*), 23 Russell Sq., London, W.C. 1, England.
British Engineering Standards Assn. (*Brit. Eng. Stand. Assn.*), 28 Victoria St., London, S.W. 1, England.
British Geological Survey, Memoirs (*Brit. Geol. Surv., Mem.*), H. M. Stationery Office, Adastral House, Kingsway, London, W.C. 2, England.
British Industries (*Brit. Ind.*), 39 James St., London, S.W. 1, England.
British Scientific Instruments Research Association (*Brit. Sci. Instruments Research Assn.*), 22 Russell Sq., London, W.C. 1, England.
British Society of Master Glass Painters (*Brit. Soc. Master Glass Painters*), 6 Queen Sq., London, W.C. 1, England.
Building Age and National Builder (*Bldg. Age*), National Trade Journals, Inc., 101 W. 31st St., New York, N. Y.
Building Economy (*Bldg. Econ.*), Ralph P. Stoddard, Guarantee Title Building, Cleveland, Ohio.
Building Research Technical Papers (*Bldg. Research Tech. Papers*), Dept. of Scientific and Industrial Research, 16 Old Queen St., Westminster, S.W. 1., London, England.
Building Science Abstracts (*Bldg. Sci. Abs.*), H. M. Stationery Office, London, England.
Bulletin de l'Académie des Sciences de Russie (*Bull. acad. sci. Russ.*). *See* Bulletin de l'académie des sciences de l'union des républiques soviétiques socialistes.
Bulletin de l'Académie des Sciences de l'union des républiques soviétiques socialistes, (*Bull. acad. sci. union rep. soviet. social.*), Academy of Science, Universitetskaya nab. 5, Leningrad, V. O., U.S.S.R.
Bulletin of the American Ceramic Society (*Bull. Amer. Ceram. Soc.*), 2525 N. High St., Columbus, Ohio.
Bulletin of the American Zinc Institute (*Bull. Amer. Zinc Inst.*), 27 Cedar St., New York, N. Y.
Bulletin de l'Association de Documentation (*Bull. Assn. Documentation*), 82 Rue Taitbout, Paris (9e) France.
Bulletin of the British Cast Iron Research Association (*Bull. Brit. Cast Iron Research Assn.*), The British Cast Iron Research Association, 24 St. Paul's Sq., Birmingham, England.
Bulletin de le Classe des Sciences académie royale de Belgique (*Bull. sci. acad. roy. Belgique*), Maurice Lamertin, 58–62 rue Coudenberg, Brussels, Belgium.
Bulletin of the Institute of Physical and Chemical Research [Tōkyō] (*Bull. Inst. Phys. Chem. Research* [Tōkyō]), Iwanami Shoten, 16 Minamijinbocho, Kanda-Ku, Tōkyō, Japan.
Bulletin International de l'Académie Polonaise des Sciences et de Lettres (*Bull. Intern. Acad. Polonaise*), Gebethner et Wolff, Rynek G. 1, Cracow, Poland.
Bulletin of the Metropolitan Museum of Art (*Bull. Met. Mus. Art*), The Metropolitan Museum of Art, 5th Ave., and 82nd St., New York, N. Y.
Bulletin Schweiz Verein Gas und Wasserfach (*Bull. Schweiz Ver. Gas Wasserfach*),

Fachschriften-Verlag & Buchdruckerei A.-G., Stauffacherquai 36–38, Zurich 4, Germany.

Bulletin de la société d'encouragement pour l'industrie nationale (*Bull. soc. encour. ind. nat.*), 44 rue de Rennes, Paris (6e) France.

Bulletin de la société française de minéralogie (*Bull. soc. franç. minéral.*), M. L. Bourgeois, 1 blvd. Henri IV, Paris (4e) France.

Bulletin technique de la suisse romande (*Bull. tech. suisse romand.*), Lausanne, Switzerland.

Bulletins of the American Physical Society (*Bull. Amer. Phys. Soc.*), Ithaca, N. Y.

Bulletins of the Australia Institute of Science & Industry (*Bull. Australia Inst. Sci. Ind.*), Institute of Science and Industry, 314 Albert St., East Melbourne, Australia.

Bulletins of the Canadian Institute of Mining and Metallurgy (*Bull. Can. Inst. Mining Met.*), 603–604 Drummond Bldg., Montreal, Quebec, Canada.

Bulletins of the Ohio Ceramic Industries Association (*Bull. Ohio Ceram. Ind. Assn.*), Lord Hall, Ohio State University, Columbus, Ohio.

Bulletins de la Société Chimique de Belgique et de la Fédération des Industries Chimiques de Belgique (*Bull. Soc. Chim. Belg.*), Rue Souveraine, 8e, Brussels, Belgium.

Bulletins of the U. S. Bureau of Labor Statistics (*Bull. U. S. Bur. Labor Statistics*), Washington, D. C.

Bureau of Foreign and Domestic Commerce. *See* Commerce Reports.

Bureau of Mines; Bureau of Standards. *See* U. S. Bureau of Mines; U. S. Bureau of Standards.

Cambridge Philosophical Society. *See* Proceedings of the Cambridge Philosophical Society.

Canadian Chemistry and Metallurgy (*Can. Chem. Met.*), Westman Press, Ltd., 57 Queen St., West, Toronto 2, Canada.

Canadian Department of Mines, Mines Branch (Can. Dept. Mines, *Mines Branch*), Canadian Department of Mines, Ottawa, Canada.

Canadian Department of Mines, Publications (Can. Dept. Mines, *Pub.*), Canadian Dept. of Mines, Ottawa, Canada.

Canadian Engineer (*Can. Eng.*), The Monetary Times Printing Co. of Canada, Ltd., 62 Church St., Toronto, Canada.

Canadian Foundryman and Electroplater, MacLean Publishing Co., 143 University Ave., Toronto, Canada.

Canadian Institute of Mining and Metallurgy. *See* Bulletins of the Canadian Institute of Mining and Metallurgy; Transactions of the Canadian Institute of Mining and Metallurgy and of the Mining Society of Nova Scotia.

Canadian Journal of Research (*Can. Jour. Research*), National Research Council of Canada, Ottawa, Canada.

Canadian Machinery and Manufacturing News (*Can. Machinery*), MacLean Publishing Co., Ltd., 143 University Ave., Toronto, Ontario, Canada.

Canadian Mining Journal (*Can. Mining Jour.*), The Industrial & Educational Publishing Co., Ltd., Garden City Press, Gardenvale, P. Q., Canada.

Cement, Mill and Quarry, National Trade Journal, Inc., 100 W. 31st St., New York, N. Y.

Centralblatt der Hütten und Walzwerke (*Centr. Hütten Walzwerke*), Wilhelmstrasse 8, Berlin S.W. 48, Germany.

Centralblatt für Mineralogie, Geologie, und Paläontologie (*Centr. Mineral. Geol.*), E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nägele) G.m.b.H., Johannesstr. 3a, Stuttgart, Germany.

Ceramic Abstracts (*Ceram. Abs.*), American Ceramic Society, 2525 N. High St., Columbus, Ohio.

Ceramic Age (*Ceram. Age*), 170 Roseville Ave., Newark, N. J.

Ceramic Industry (*Ceram. Ind.*), Industrial Publications, Inc., 407 S. Dearborn St., Chicago, Ill.

Ceramic Research Institute [U.S.S.R.]. *See* Transactions of the Ceramic Research Institute [U.S.S.R.].

Ceramic Society [England]. *See* Transactions of the Ceramic Society [England].

Ceramics and Glass [Moscow], Scientific-Technical Council of Glass and Porcelain Industry, 8/2 Miasnitskaia, Moscow, U.S.S.R.

Céramique, 84 rue d'Hauteville, Paris (Xe), France.

Céramique et Verrerie, 13 rue de Petites-Écuries, Paris, France.

Chaleur et industrie (*Chaleur ind.*), 5 rue Michel-Ange, Paris, France.

Chemical Abstracts (*C. A.*), Chemistry Building, Ohio State University, Columbus, Ohio.
Chemical Age (*Chem. Age*), 1182–28th St. New York, N. Y.
Chemical Age [London] (*Chem. Age* [London]), Benn Brothers, Ltd., Bouverie House, 154 Fleet St., London, E.C. 4, England.
Chemical Engineering and Mining Review (*Chem. Eng. Mining Rev.*), Tait Publishing Co., Pty., Ltd., 39 Queen St., Melbourne, Australia.
Chemical Markets (*Chem. Markets*), Chemical Markets, Inc., 25 Spruce St., New York, N. Y.
Chemical & Metallurgical Engineering (*Chem. Met. Eng.*), McGraw-Hill Co., Inc., 10th Ave., at 36th St., New York, N. Y.
Chemical, Metallurgical, and Mining Society of South Africa. *See* Journal of the Chemical, Metallurgical, and Mining Society of South Africa.
Chemical News and Journal of Industrial Science (*Chem. News*), Merton House, Salisbury Sq., London, E.C. 4, England.
Chemical Society [London]. *See* Journal of the Chemical Society [London].
Chemical Technology [Japan] (*Chem. Tech.* [Japan]), Kagaku-Kogei-Sha, Kiriu, Japan.
Chemical Trade Journal and Chemical Engineering (*Chem. Trade Jour.*), Davis Bros., 265 Strand, London, W.C. 2, England.
Chemicals. Trades Reporting Bureau, Inc., 51 Vesey St., New York, N. Y.
Chemické Listy pro vědu a prumysl (*Chem. Listy*), E. Beauforta, Jungmannova tř 21, Prague II, Czechoslovakia.
Chemicky Obzor, Bredovská 3, Prague II, Czechoslovakia.
Chemie der Erde (*Chem. Erde*), Gustave Fischer, Jena, Germany.
Chemiker-Zeitung (*Chem. Ztg.*), Walter Roth, Köthen, Germany.
Chemische Fabrik (*Chem. Fabr.*), Verlag Chemie, G.m.b.H., Berlin, W. 10, Germany.
Chemische Rundschau für Mitteleuropa und den Balkan (*Chem. Rund.*), Eskü-ter 5, Budapest IV, Hungary.
Chemische Weekblad (*Chem. Weekblad*), N. V. D.-B. Centen's Uilgevers-Maatschappi O. Z. Voorburgwal. 115, Amsterdam, Holland.
Chemisches Zentralblatt (*Chem. Zentr.*), Deutschen chemischen Gesellschaft, Sigismundstr. 4, Berlin, W. 10, Germany.
Chemist-Analyst, J. T. Baker Chemical Co., Phillipsburg, N. J.
Chemistry and Industry (*Chem. and Ind.*), Society of Chemical Industry, Central House, 46–47 Finsbury Sq. London, E.C. 2, England.
Chimie & Industrie (*Chim. & ind.*), Société de chimie industrielle, 49 rue de Mathurins, Paris, France.
Ciment, Société anonyme de publications industrielles, 20 rue Turgot, Paris, France.
Classe des sciences académie royale de Belgique. *See* Bulletin de la Classe des sciences académie royale de Belgique.
Clay Products News and Ceramic Record (*Clay Prod. News*), Keith-Wilkes, 79 Adelaide St., East, Toronto 2, Canada.
Clay-Worker, T. A. Randall & Co., Inc., 211 Hudson St., Indianapolis, Ind.
Collections of the Czechoslovakian Chemical Committee (*Collection Czecho. Chem. Comm.*), E. Votoček & J. Heyrouský, Albertov 2030, Prague II, Czechoslovakia.
Colliery Engineering (*Colliery Eng.*), 33 Tothill St., Westminster, London, S.W. 1, England.
Combustion, Combustion Publishing Co., 11 Broadway, New York, N. Y.
Commerce Reports (*Commerce Repts.*), Bureau of Foreign and Domestic Commerce, Dept. of Commerce, Washington, D. C.
Commercial and Industrial Gazette (*Commercial Ind. Gaz.*), Pretoria, S. Africa.
Communications of the Kodak Research Laboratory (*Comm. Kodak Res. Lab.*), Eastman Kodak Co., Rochester, N. Y.
Compressed Air Magazine (*Compressed Air Mag.*), Compressed Air Magazine Co., 11 Broadway, New York, N. Y.
Comptes rendus hebdomadaires des séances de l'académie des sciences (*Compt. rend.*), Gauthier-Villars et Cie, 55 Quai des Grands-Augustins, Paris (6e) France.
Concrete, Concrete Publishing Co., 139 N. Clark St., Chicago, Ill.
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Compiled by

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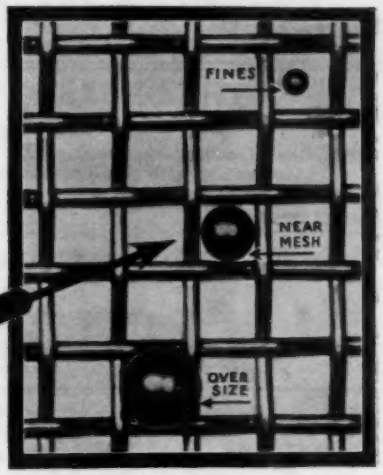

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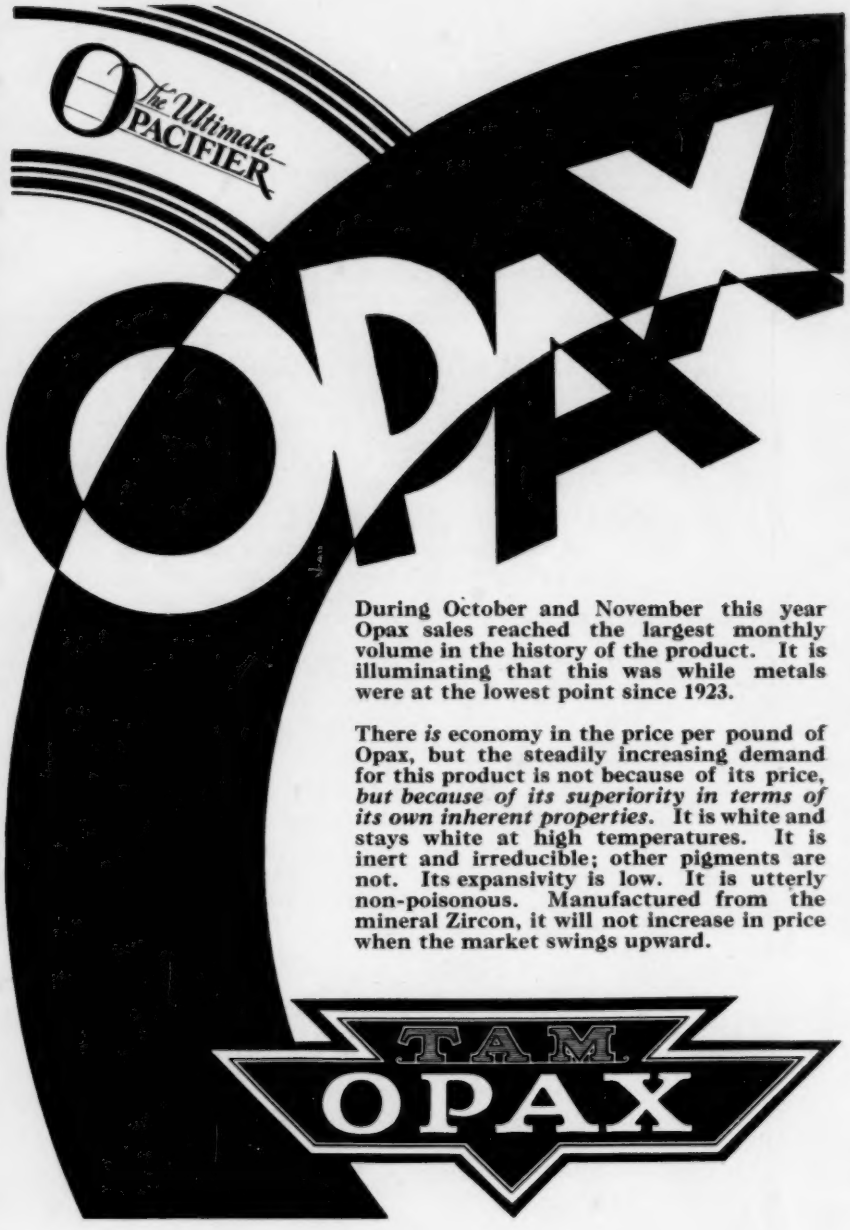

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Vol. 8 **December, 1929** **No. 12**

EDITORIAL

OUR ABSTRACTS

The following table shows the number of abstracts published by this SOCIETY during the past three years. This bibliographic service keeps our members in touch with the best and with practically all of the published information on ceramics. We have had very gratifying comments on the value of these abstracts to those who are "thinking" and striving to accomplish. Several have said that these alone are worth to them many times the annual dues paid.

NUMBER OF ABSTRACTS PUBLISHED

Year	Abrasive	Art	Cement, lime, and plaster	Enamel	Glass	Heavy clay products	Refractories	Terra cotta	White wares	Equipment and apparatus	Kilns, furnaces, fuels, and combustion	Geology	Chemistry and physics	General	Total
1927	45	222	349	96	714	208	402	32	177	186	243	133	422	330	3559
1928	205	295	309	154	775	264	433	58	258	334	447	167	486	362	4547
1929	444	495	269	229	718	281	589	76	300	276	365	231	505	506	5285

The abstracts are for the most part made by our abstractors. In addition the abstracts of every other society and of trade journals in English,

German, and French are read in the editorial office and those abstracts which pertain to ceramics and are not covered by our own abstractors are copied with credit given to their source.

All abstracts are checked each month for possible duplication of any that have been published during the past three years. Two card indexes showing authors, titles, and journal references for the past three years are the working tools used to prevent duplications.

The abstracts from all sources are then edited, classified, and indexed. Not all abstracts submitted are used and each abstract is edited to show the essence of the article in question.

In December an index for the year is published showing author and title. The substance of each abstract is cross-indexed.

Also in December there is published a list of the journals, from which abstracts have been obtained, together with the name and address of the publishers.

Considerable effort is made to have our abstracts complete, concise, and accurate and it is aimed by the index and the journal list to furnish a ready reference to the information contained in the abstracts. These abstracts, indexes, and journal lists are prepared by human beings, striving to do their utmost in volume and quality. They can be proud of their accomplishments.

This monumental work would be for naught, however, if these abstracts, indexes, and journal lists are not used. We submit that for ideas, inspiration, and information in ceramics one cannot find anything more replete and accurate than our abstracts.

This work costs much money. The abstracts have been increased as facilities for securing them have been developed. It is the intention that these facilities will be increased and improved regardless of the increasing costs with the confidence that the members of the SOCIETY will show their appreciation of this service by providing the required means.

PAPERS AND DISCUSSIONS

SIGNIFICANCE OF THE STANDARD FIRE TEST TO HEAVY CLAY PRODUCTS MANUFACTURE[1]

By H. D. Foster

ABSTRACT

This paper points out the origin and basis of the fire-test procedure, listing five places where fire tests of building walls can be made and the type of work done at these various laboratories. Some data are given to show the need and general trend of research work in heavy clay products leading to better fire resistance.

Introduction

Fire tests have been made for some time, the first on which records are now available being made in New York City between 1890 and 1900.[2] It is only within the past few years, however, that they have been standardized.[3]

The Test

The fire-test procedure as set up by the National Board of Fire Underwriters, the Underwriters' Laboratories, and the U. S. Bureau of Standards, is now recognized as a tentative standard by the American Society for Testing Materials. The tests must duplicate conditions of use, for instance, the loading of the wall, the exposure of one side to fire as would obtain in a burning building, and the quenching of the hot side with water. If the material is to be used for a panel or enclosure wall it must be built in strong frames which will provide restraint as is set up in actual use between building columns and girders. If the wall is to be used unrestrained in the building, it must be tested when under this unrestrained condition, or if it is to be used as a load-bearing wall, load must be applied during the test.

Only one side of the test wall is subjected to fire exposure, the supposition being that fire attacks only the one side. We are interested in the fire resistance of the wall primarily as it concerns its ability to hold back the fire or keep it from spreading to other parts of the building. It has been hard to standardize fire-test procedure because positive measurements of temperatures[4] of fires in burning buildings have been taken only within the past three years. It has been necessary to rely on molten fragments

[1] Presented at the Annual Meeting, American Ceramic Society, Chicago, Ill., February, 1929. (Heavy Clay Products Division.) Received February 28, 1929.

[2] "Standard Fire Tests," *Proc. 13th Ann. Meeting Building Officials Conference.*

[3] For the Standard Fire Test see *Proc. A.S.T.M.*, **26** [1], (1926), also Book of A.S.T.M. Tentative Standards, 1926.

[4] "The Severity of Building Fires," *Proc. 14th Ann. Meeting Building Officials Conference.*

of metals of known fusion points found in the débris. From these data and other observations, a standard exposure temperature curve has been adopted. This temperature curve, which is the basis for the fire test, requires that the fire be so regulated that the average temperatures developed shall approximate the following:

(Minutes)	(°F)	(Approx. °C)	(Hours)	(°F)	(Approx. °C)
5	1000	538	1	1700	927
10	1300	704	2	1850	1010
30	1550	843	4	2000	1093
			8	2300	1260

Where Tests Are Made There are now five places where fire tests are made: Columbia University, the Underwriters' Laboratories, the Bureau of Standards, the Engineering Experiment Station of the Ohio State University, and the Laboratory of the Portland Cement Association. Tests at Columbia University are usually made to determine the fire resistance of a specific construction for the Department of Buildings of the City of New York.

At the Underwriters' Laboratories tests are generally made at the request of manufacturers and the results and fire-resistance periods thus established are often used by the National Board of Fire Underwriters' and Insurance Rating Bodies as a guide in setting up insurance rates. The Underwriters' Laboratories have also made several series of tests to aid manufacturers in developing greater fire resistance.

The fire tests at the Bureau of Standards are made to establish the fire resistance generally attainable with any material as a class. The Bureau has already made two series of tests establishing the fire resistance of brick and of hollow load-bearing tile.

The fire tests at the Engineering Experiment Station of the Ohio State University are made principally with the idea of improving product, design, and construction. The work is carried on in conjunction with the Heavy Clay Products Experimental Plant. Tests now being made are designed to improve the fire resistance of structural clay partition tile. This furnace is also so designed as to make possible tests for the State Board of Building Standards which is empowered by law to call upon the Engineering Experiment Station for such work.

The fire tests at the laboratory of the Portland Cement Association are presumably made to aid in the development of higher fire resistance of concrete.

Fire Protection

In the fire test, the fire-resistance period or the time that a wall or other construction will give protection against a standard fire is determined by one of three things: (1) the failure or collapse of the wall or other construction under load, (2) the passage of smoke or flame through cracks

or damaged units, or (3) the building up of a temperature on the unexposed surface high enough to cause ignition of combustible material which might be in contact with it. This temperature rise has been standardized to 250 °F (138.9 °C).

For heavy clay products the end-point of the test or the fire-resistance period is usually determined by the time required to obtain the temperature rise on the unexposed side. This time is governed by the specific heat and mass of the wall, as well as its design. If the wall is of solid brick, the variation on this latter score is small; if of hollow construction, the resistance may be half of what it would be if solid. This is illustrated by tests made at the Bureau of Standards in which an 8-inch unplastered solid wall gave a fire-resistance period of five hours but when built hollow, as for the "Hollow Rolok" construction, a fire-resistance period of two and one-half hours was obtained.[5]

In hollow tile construction the type of the units, the number of cells in the unit, and the type of workmanship and construction govern the fire-resistance period of the wall when the failure is due to temperature rise on the unexposed side. This is also illustrated by tests made at the Bureau of Standards[6] in which 8-inch unplastered walls of 3-cell end construction, T-shaped or double-shell (plus three interior cells) tile gave an average fire-resistance period of $2^3/_4$ hours, while for 3-cell side construction or double-shell plus one or two interior cells the period was one-half hour less, and for 2-cell or 3-cell end or side construction the period was one hour less. This illustration alone shows the possibilities of properly designed units and the field for development work in the design of hollow tile. That this field of endeavor is productive has been proved by the recent appearance of several most excellent designs.

The fire-resistance periods are increased from 50 to 100% by the use of either gypsum or cement plaster on both sides of the wall as would usually be the condition of the wall when in service.

Generally, fires are not permitted to burn long enough to cause wall failure due to heat transmission. Various masonry materials are subject to more or less fire damage even from fires of short duration. These damages often distinguish comparatively between clay products and competitive materials. Some tile designs and ware made from some clays are more susceptible to damage than are others. The manufacturer should know this and avoid these conditions. Already the A.S.T.M. has discovered that hard-fired tile are very susceptible to spalling and have inserted a clause in their specifications ruling out such material.

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[5] "Fire Resistance of Materials," *Building Economy*, p. 20, (Sept.) 1927. (Common Brick Mfrs. Assn. of Amer.)

[6] "Fire Resistance of Hollow Load-Bearing Wall Tile," *Jour. of Research* (Bur. of Stand.), **2** [1], 334 pp. (1929).

Fire Losses

The fire loss in the United States has been growing at a tremendous rate, entirely out of proportion to the increase in population. This can be halted only by better and more fire-resistive building construction. For the ten-year period of which 1910 was the middle year, the average yearly fire loss was $237,497,000 which increased 81.7% to $432,686,000 for the ten-year period of which 1920 was the middle year. The population increased from 91,972,266 to 105,710,620 or only 14.9%. The fire loss last year was over $500,000,000.

The fire loss is not entirely eliminated in the so-called fireproof or fire-resistive building. This is the type of construction in which heavy clay products are used. To illustrate this point, Rudolph P. Miller has made an analysis[7] of the record of 1924 of 23 cities in the United States with populations varying from 50,000 to 150,000. The total loss was over $6,388,912. The number of buildings in those 23 cities was 468,040. Of those, 8320 were of fireproof construction, 4980 being of steel frame and 3340 of reënforced concrete. The total number of fires in that year, in the 23 cities, was 8365; 25 of them were in steel frames and 77 in reënforced concrete, or 100 fires in buildings of fireproof construction. The total number of buildings that had fires in them during that year is 1.8% of all of the buildings. Of the buildings of fireproof construction, 1.2% had fires in them; of non-fireproof buildings, 18.0%, or fifteen times as many as in fireproof buildings.

Fires will originate in fireproof buildings as well as others and it is the task of clay products manufacturers to produce material of sufficient fire resistance to prevent the spreading of these fires.

Code Writing

Building officials and writers of building codes are following this reasoning and instead of specifying materials or wall thicknesses for fire-resistive units in buildings they are specifying the amount of protection required for the various occupancies. This is economical and fair, for taking the two extremes, long and hot fires would occur in buildings used as warehouses and would require fire walls or partitions of high fire resistance, while in office buildings short and more moderate fires might be expected which would not require very high fire-resistive walls to prevent spreading from the point of origin.

The Pacific Coast Building Officials Conference has prepared a Uniform Building Code on this basis. Other codes have been prepared, modeled in part after this. New codes are to be prepared for our two largest cities,

[7] "The Standard Fire Test," *Proc. 14th Ann. Meeting Building Officials Conference*, pp. 81–85.

Chicago and New York, after which many of the smaller cities may model their codes, and it is reasonable to believe that these two codes will specify required fire-resistance periods. It is, therefore, important that clay products manufacturers know the resistance periods of their materials and increase them if possible. Competition must be met on the basis of performance in tests.

ENGINEERING EXPERIMENT STATION
OHIO STATE UNIVERSITY
COLUMBUS, OHIO

CERAMIC RESOURCES OF VIRGINIA AND THEIR DEVELOPMENT[1]

BY J. W. WHITTEMORE

Introduction

Virginia may be divided into three sections in regard to its ceramic resources: the coastal plain, Piedmont, and mountain areas.

Coastal Area The first of these, the coastal plain, contains chiefly clays of the Tertiary system which are suitable for the manufacture of all types of fired clay building material. Nearly all of these clays fire to a red, brown, or buff color and vitrify at a fairly low temperature.

Within this area are several deposits of diatomaceous earth, one of them near Wilmont being used for the manufacture of a porous brick.

Piedmont Area The Piedmont area is made up chiefly of the residual clays and shales derived from the crystalline rocks. This area contains kaolins, feldspars, ochers, bauxite, cyanite, shales, and clay. The kaolins are usually derived from the weathering of pegmatites. The feldspars contain a large amount of mica and quartz and would require careful working since these impurities range from 8-mesh to 300-mesh.

Mountain Area The mountain area in the western part of the State contains chiefly residual material derived principally from the limestones and shales. Within this area are several deposits supplying fire clays, white firing clays and shales, kaolin, and feldspar. There are a few of these deposits being worked, and nearly all of the feldspar and kaolin that is being mined is used outside the State.

Production The census report of 1927 of the Department of Commerce shows thirty-six manufacturers of common brick, and six manufacturers of face brick in the state of Virginia. These industries produce approximately 220 million common brick and 45 million face brick.

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[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Chicago, Ill., February, 1929. (Heavy Clay Products Division.)

There are a few plants in the State producing feldspar, kaolins, ocher, bauxite, and cyanite, but only on a very small scale. Only one plant is manufacturing hollow building block and this operation was started in the past year. There is one plant manufacturing fireclay brick and shapes, and one plant manufacturing pottery and chinaware. There are no plants within the State manufacturing drain tile, paving brick, floor tile, wall tile, roofing tile, or terra cotta. Considering the amount of raw ceramic materials not being used at the present time, and the increasing demand for these products there are great possibilities for diversified manufacturing and expansion of the ceramic industries within the State.

Survey Projects

In the fall of 1928 the Virginia Polytechnic Institute established a Ceramic Engineering Department with the purpose of surveying the raw ceramic resources, the ceramic plants, and the ceramic needs of the State. It is the intention of this Department to aid in every possible way the present manufacturer, helping him with any problems that confront him in the manufacture of his products.

Very few of the ceramic plants in Virginia have changed their mode of manufacture since they were originally planned. The open drier and updraft clamp kiln, worn out machinery, and other practices which run the cost of production high, are being used. These facts make it difficult for many of the plants to meet the competition of the modern manufacturer in Virginia and of the neighboring states.

Another work of this Department is to promote the utilization of the raw ceramic resources such as kaolin, feldspar, and glass sands, since many of these are not being used at the present time. Very little has been done on the investigation of the raw materials for the glass and cement industries. At the present time, however, there is one cement mill using shale, and in three different locations sands are dug and shipped out of the State for the glass industry. A complete survey of these resources will be made in order to determine the location, extent, and value of all of the deposits within the State. This will be of value to the manufacturer already located and to anyone desiring such information for the installation of a new plant.

Equipped Laboratory The ceramic laboratory at Virginia Polytechnic Institute is being equipped with modern apparatus for the complete testing of clays and other ceramic materials. Chemical analyses are made in conjunction with the Chemistry Department of the College, and the physical tests are made in a laboratory outfitted so that the tests will comply with the requirements of the AMERICAN CERAMIC SOCIETY and the A.S.T.M.

That the complete testing of clays for the manufacture of heavy clay

products may be made, another room is outfitted with a jaw crusher, rolls, wet and dry pan, screens, auger machine with necessary dies, dry press, cutter, automatically controlled drier, and oil-fired kilns. For pottery and enameling, the equipment consists of a clay-washing and mixing machine, filter press, jigger and jolly, glaze mills, molds, and the necessary kilns. A whirlpool classifier, magnetic separator, and screens will be used for the work on the kaolins, feldspars, and other high-grade clays.

The kilns to be used are a large oil-fired muffle furnace with forced draft, a small oil-fired fusion furnace with optical pyrometer, and a large down-draft, oil-fired kiln which will be constructed in the laboratory. The materials testing laboratory of the Mechanical Engineering Department, located in the same building, has complete equipment for the testing of the finished product, and is being used for this part of the work.

Ceramic Instruction After the surveys have been completed and it is deemed practical, courses will be offered in ceramic engineering for students taking other engineering work, and eventually it is planned to institute a complete curriculum in ceramic engineering if it seems justified.

Results to Date

Although this work has just begun, results are already beginning to show. The manufacturers of brick and tile have become organized into a Virginia Clay Products Association with a membership of over 60% of the manufacturers and representing 75% of the production in the State. Several of these have already asked for aid in problems encountered in their plants and results are being obtained.

In view of the fact that a program, similar to that described here, has added a million dollars a year to the ceramic developments in North Carolina and very much the same thing in Georgia, it is believed that with the large amount of raw material in Virginia, the growing demand for ceramic products, and the coöperation of the manufacturer and the Department of Ceramic Engineering at Virginia Polytechnic Institute there is a splendid future for the ceramic industries in Virginia.

VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VA.

ACTIVITIES OF THE SOCIETY

REPORT OF NOMINATING COMMITTEES

Officers for 1930–1931

	Committee No. 1	Committee No. 2
For President	Edward Orton, Jr.	Edward Orton, Jr.
For Vice-President	Paul E. Cox	Alexander Silverman
For Treasurer	H. B. Henderson	H. B. Henderson

EDWARD ORTON, JR., DEFINES HIS PLATFORM FOR SERVICE IF ELECTED PRESIDENT

November 5, 1929

To THE COMMITTEES ON NOMINATIONS:

Dear Sir:

In reply to your communications regarding my willingness to run for the presidency of the AMERICAN CERAMIC SOCIETY, would say that after having given careful consideration to the subject I have decided to allow my name to go in, and if elected will serve the SOCIETY to my best ability as president.

My delay in reaching this decision has been due in part to a feeling that I have been already honored by the SOCIETY on numerous occasions, although never president, and that unless I could render some outstanding service to the SOCIETY, I would not be justified in taking up the duties of the presidency.

In my opinion, there is one service which the SOCIETY needs to have done for it, and some of my friends have indicated that they think I can perform this service very advantageously. I refer to the matter of creating a special classification in our membership, to which a small and selected group might be elected, the basis of whose selection would be *outstanding achievement*, chiefly in the field of ceramic technology, but including also real achievements of a practical sort in the ceramic arts. In the earlier years of the SOCIETY's life, election to Active Membership carried this significance, and for that reason the number of Active Members was small in proportion to the total membership. Since considerable changes in the Constitution were made some years ago, Active Membership has ceased to carry this meaning of definite ceramic achievement, and has become a mere matter of paying dues. I fully believe and know that many others also feel that the SOCIETY has lost something of value from this fact, and that we should rectify this situation.

If I am elected, I should expect to devote my best energies to bring about action to accomplish this general purpose. The details of the methods and procedure, I should, of course, not attempt to indicate at this time.

I also think that the SOCIETY should give careful thought to its policy of development at this time. I find two schools of thought existing. One may be summarized in the idea that the SOCIETY is a scientific organization, whose business is to represent the technical aspects of ceramic science and technology, and that this alone is a sufficient field for it to occupy. I find another group which thinks that the SOCIETY must broaden out, and make itself felt more quickly and definitely in the direction of making our present ceramic knowledge, which is constantly being increased by researches of the membership, more available for use by the various ceramic industries, in broadening their sales through the creation of new types of products, and in meeting the competition which their products are constantly encountering from other nonceramic products. Of course such action cannot wholly be differentiated from promotion and sales work, and while promotion and sales matters are not properly within the direct purview of the

SOCIETY, this group feels that it is the business of the technical men to greatly concern themselves with making their ceramic researches of more direct use to the commercial side of the business. These activities would necessarily include more or less expensive programs, including contacts with various groups through trade associations, the setting of standards and specifications, etc., in order to represent ceramic products properly and to push their introduction and use.

As between these two schools of thought, the SOCIETY will be compelled to make a choice. Some promotion work and researches for the benefit of sales organizations has been and is being done by the SOCIETY. The question is whether *more* money and greater activity should be put into this department of the SOCIETY'S work in the future, or *less*. My personal belief is that the SOCIETY should not stand on the fence in this matter, and that it can and should, so far as the limitation of its budget permits, assist in interpreting its ceramic researches so as to make them more directly useful to sales organizations, and in promoting the business side of the ceramic industries. In other words, the decision between purely scientific and technical work *for itself*, and scientific and technical work *as a means to industrial expansion* is really the question at issue. My policy as president would be to have the SOCIETY develop in the latter line, as far as its budget can be made to go.

Of course there are many other aspects of the SOCIETY'S work which might be discussed, but I think that I have made myself sufficiently clear as to my attitude on what I regard as the two outstanding questions as to the SOCIETY'S future policy. I should want every one who casts a vote for me to know in advance where I stand, so that if elected I might confidently look forward to their loyal backing and support. I am not aware in what way the contents of this letter can be made public to the membership, but think some way should be found to do it before the election is held.

Yours very truly,

EDWARD ORTON, JR.

THIRTY-SECOND ANNUAL MEETING, AMERICAN CERAMIC SOCIETY

Royal York Hotel, Toronto, February 16, 17, 18, 19, 20, 1930

Program

(*a*) The Canadian Committee has arranged for Sunday, February 16
  (1) Reception in Royal York Hotel by Canadian Ceramists, Provincial Executives, University and Museum Authorities.
  (2) Conducted tours through Toronto and the Museums.
  (3) Organ recital and concert by chorus of 200 voices at 9:00 P.M.

(*b*) Monday will be devoted to general meetings, committee meetings, and group dinners.

(*c*) Tuesday and Wednesday will be given over to Division meetings for reading and discussing papers.

(*d*) Thursday will be devoted to plant trips in and about Toronto, and Friday out of Toronto.

(*e*) From present indications, it is certain that more than 1000 will attend these meetings.

(*f*) Special railroad rates of one-half fare on return trip on certificate basis have been granted by all passenger associations.

(*g*) The Royal York Hotel has made a flat room rate of $5.00 per day for single, and $8.00 per day for double rooms.

Exhibits

(*a*) See floor plan of Convention Floor and Main Lobby Mezzanine.

FIG. 1.—Royal York Hotel, where all events of Ceramic Week will be held. Room rates $5.00 single, $8.00 double. Make your reservations early.

(*b*) Exhibits of light equipment, ceramic materials, and products are provided for in the Convention Floor Foyer and in the Lounge on the Mezzanine Floor.
(*c*) These two floors are adjacent with four stairway connections.
(*d*) Registration will be in the Convention Foyer.
(*e*) Meetings will be held in the Ball Room and in the two Halls on the Convention Floor. Also, in Private Dining Rooms 9, 6, 1, and 2.
(*f*) Space rental including furniture and signs will be 50c per square foot; minimum space 50 square feet per exhibitor.
(*g*) Exhibit space plus one full page advertisement in February *Journal* at regular *Journal* rates plus 25¢ per square foot for exhibit space.
(*h*) Apply for space to the AMERICAN CERAMIC SOCIETY, 2525 North High St., Columbus, Ohio.

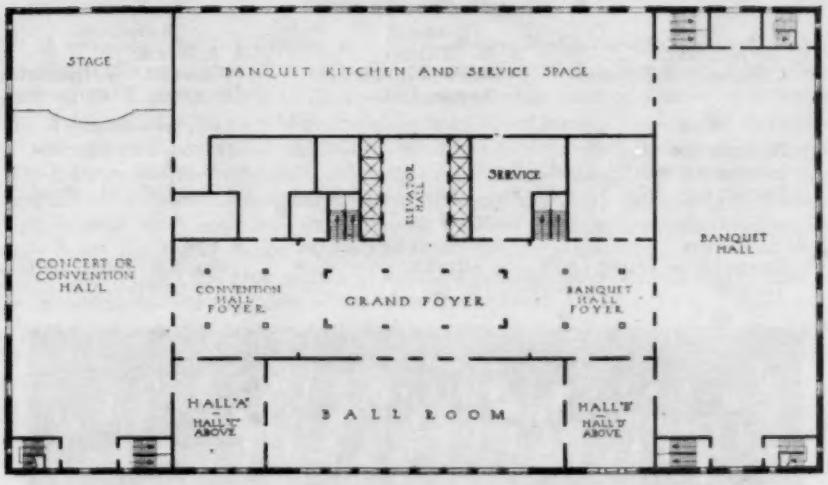

FIG. 2.

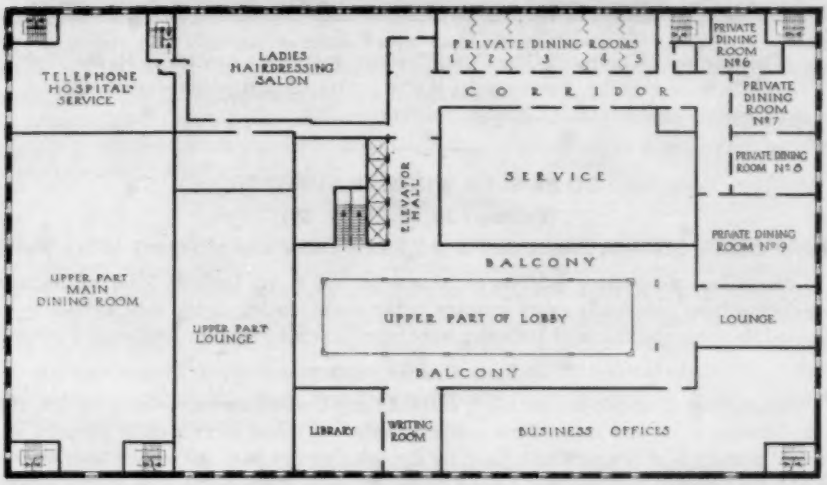

FIG. 3.

Committees

CHAIRMAN	VICE-CHAIRMAN	SECRETARY-TREASURER
BRIG.-GENERAL C. H. MITCHELL Dean Faculty of Applied Science and Engineering, University of Toronto, Toronto	HAROLD F. DINGLEDINE National Sewer Pipe Co., Ltd. Aldershot, Ont.	GORDON C. KEITH 49 Turner Road Toronto 10, Canada
WM. BURGESS A. U. COTE	RYLAND H. NEW W. J. NICHOLSON	D. S. STAIRS PROF. W. G. WORCESTER

Divisional Representatives

Art
C. H. MITCHELL
University of Toronto

Enamel
F. W. MOFFAT
Moffat's Limited,
Weston, Ont.

Refractories
H. I. DARBY
National Refractories
Limited, Toronto, Ont.

Glass
J. H. SEPHTON
Dominion Glass Co., Ltd.,
Hamilton

Terra Cotta
HECTOR DESJARDINOS
Montreal Terra Cotta
Co., Ltd., Montreal

Enamel
W. S. GIBSON
General Steel Wares, Ltd.,
Toronto

Heavy Clay Products
HOWELLS FRÉCHETTE
Ottawa

White Wares
B. STONE
Smith & Stone, Limited,
Georgetown, Ont.

The Harmony Choir and Glee Club, Toronto, will give a concert in Royal York Hotel, Sunday evening, February 16, 9 P.M. Free of charge to delegates attending meetings of AMERICAN CERAMIC SOCIETY.

TO BE SEEN WHILE IN TORONTO

(February 16, 17, 18, 19, 20)

Royal Ontario Museum Boasts One of the Finest Collections of Pottery in the World

The china and pottery exhibits to be seen at the Royal Ontario Museum include specimens from practically every country in the world, dating as far back as 6000 B. C. Indeed there are specimens of alabaster ware from Upper Egypt, of a predynastic period.

Early Grecian Pottery

Among the oldest exhibits are many cases of early Corinthian ware, dating back to the 6th Century B. C., and taken from ancient tombs. Typical of this early Grecian unglazed pottery is a "Panathensic Vase" of the 5th Century B. C. This is a large urn on which are pictured mythological subjects, characteristic of the decoration of this period. With the background of terra cotta, the design was applied by filling the contours of the figures with black varnish. This particular vase, filled with olive oil, was awarded as a prize at the horse races held at Athens in honor of the goddess Athena.

The Roman pottery which includes a great variety of vases, urns, huge wine cups, strange little lamps, and other things also dates back to centuries before Christ, having been found in excavations of old Roman dwelling places.

There is some, though not a great deal of Egyptian pottery, for Egypt, lacking pottery clay, used more hard stone for household vessels. The Greeks on the other hand were blessed with good clay, and their work of about 500 B. C., is the finest pottery the world has ever known.

Introduction of Glazing

It was about the 2nd Century B. C., that any satisfactory results were achieved in Greece and Rome in glazed pottery. China soon mastered the art as far as it had gone, and in the Ontario Museum, you will see case after case of Chinese pottery of about this period. These exhibits consist principally of tomb groups—small statuettes of the wives, retainers, and animals of wealthy Chinese, which had been entombed with the man when he had died. Originally the custom prevailed of killing and burying with a man his actual wives and relatives, in order that they might be on hand to serve him in the next world; about the 1st Century these unfortunates were spared their martyrdom, small images representing them being substituted.

Most of these tomb groups, though in glazed pottery, are of an ugly dirty shade of green, which marked the limits of the art at that period. Later a Persian discovered a method of using tin in the glaze, whereby it became possible to produce any color. From Persia it went to Morocco. The Moors introduced it into Spain and quickly the art spread over Europe, and today in the Ontario Museum there are many pieces of this period, which was about the 15th Century.

Chinese Pottery

The Chinese pottery exhibit already referred to, includes nearly the world's supply of early specimens. Explanatory volumes are now being prepared on this exhibit, and Ontario will be in the unique position of being the world's authority. The collection includes the complete range, from the early, crude tomb groups to the exquisitely delicate designs and colors in Canton enamel on Chinese snuff bottles. There are large and rare Chinese porcelain vases made for various Emperors of the Chang dynasty (1643–1912), elaborate porcelain figures of the 18th Century depicting Chinese gods, amazingly perfect down to the smallest detail.

An exhibit of Chinese glass, dated 1738, is another interesting feature. This Chinese glass is proclaimed by critics to be the best glass the world has ever produced, both in form and color.

Anglo-Saxon Pottery

As a race of people inclined to look upon ourselves as much farther advanced than the Eastern nations, it is enlightening to see the early specimens of Anglo-Saxon pottery. In the 5th Century, when Eastern nations were doing beautiful work, our forefathers were using vessels more crude in design and workmanship than that done in Greece and Cyprus, five thousand years B. C. We cannot dispute it because there is the evidence in various pieces of Anglo-Saxon pottery. It was not until the time of Charles I that any skill was used in this work, and then it was due to the reigning king who brought Italian potters to London to teach the art.

From Many Countries

It must not be assumed that all the pottery and glass in the museum is of the very early centuries. There are wonderful collections of Persian pottery of the XI century, a joy in the wonderful blues and greens.

The collection of majolica ware covering the 16th and 17th Centuries is extensive and beautiful.

There are beautiful examples of the famous Venetian glass, some of the 16th Century. One glass and enamel plate was made in Venice in 1513 for Pope Leo XX. In contrast to this delicate work, there are stoneware beer mugs of the time of William of Orange.

There is also a large collection of pottery made by the North American Indians of a very early date.

English Wedgwood and examples of work of the Staffordshire potteries are other interesting features.

But it is a hopeless task to convey any proper conception of the treasures to be found here, and one can only urge that all interested in the manufacture of pottery, china, and glass, should take advantage of the AMERICAN CERAMIC SOCIETY Meeting in Toronto, Canada, to visit the Royal Ontario Museum. The Canadian Committee has arranged a visit to the Museum on Sunday afternoon, February 16. Buses will take the members from the hotel to the Museum and back.

NEW MEMBERS RECEIVED FROM OCTOBER 1 TO NOVEMBER 1

PERSONAL

Tracy Bartholomew, Duquesne Slag Products Co., 704 Diamond Bank Bldg., Pittsburgh, Pa.; Manager of Research and Tests.
Raymond E. Birch, Engineering Experiment Station, Roseville, Ohio; Research Engineer.
Geoffrey Everett Cunningham, Department of Ceramic Engineering, Iowa State College, Ames, Iowa; Assistant Professor.
Emery L. Hedgecock, 206 Broad St., Martinsville, Va.; President, Madison Shale Brick Co., Inc.
Gerard A. Murray, Route No. 6, Bessemer, Ala.; Refractories Engineer, Tennessee Coal, Iron & Railroad Co., Fairfield, Ala.
W. J. Nicholson, National Fire Proofing Co. of Canada, Ltd., Dominion Bank Bldg., Toronto, Ont., Canada; General Manager.
W. L. Stafford, Johns-Manville Corp., Manville, N. J.
Carl R. Suksdorf, Box 259, Troy, Idaho; President and General Manager, Idaho Ceramic Materials Co.

STUDENT

Walter Louis Brauer, Iowa State College, Ames, Iowa.
A. H. Brown, Jr., Iowa State College, Ames, Iowa.
Walter David Ford, Ohio State University, Columbus, Ohio.
Wendell Glick, Ohio State University, Columbus, Ohio.
Glenn W. Johnson, Iowa State College, Ames, Iowa.
Fred Kettenring, Jr., University of Washington, Seattle, Wash.
Paul W. Leppla, University of Illinois, Urbana, Ill.
Kenneth C. Lyon, University of Illinois, Urbana, Ill.
Theo. Meyer, Iowa State College, Ames, Iowa.
Dwight Garrison Moore, Iowa State College, Ames, Iowa.
Kenneth Morris, Iowa State College, Ames, Iowa.
G. M. Petersen, Iowa State College, Ames, Iowa.
Robert Rowland Thomas, Jr., University of Illinois, Urbana, Ill.

Membership Workers' Record

PERSONAL		STUDENT	
H. T. Coss	1	A. I. Andrews	1
Paul E. Cox	1	W. F. Copp	2
Dorothy A. Texter	1	R. K. Hursh	1
E. Ward Tillotson	1	John B. Lyon	1
Hewitt Wilson	1	D. A. Moulton	7
Office	3	Hewitt Wilson	1
Total	8	Total	13
		Grand Total	21

ROSTER CHANGES IN OCTOBER

HONORARY*

Nederlandsche Vereeniging Van Aardewerkfabrikanten, Mr. H. Mulderije, Secretary, Keizersgracht No. 586, Amsterdam, Holland. (Singel 303.)

* Addresses within the parentheses ( ) represent the old address.

CORPORATION*

Porcelain Enamel & Mfg. Co., Karl Türk (voter), Eastern and Pemco Avenues, Baltimore, Md. (O'Donnell and Eighth Sts.)

PERSONAL*

Blumenthal, George, Jr., Vitro Mfg. Co., Corliss Sta., Pittsburgh, Pa. (407 S. Dearborn St., Chicago, Ill.)
Bopp, Harold F., 2403 Salutaris Ave., Cincinnati, Ohio. (121 7th St., Dundee, Ill.)
Carter, C. C., 509 High St. S. W., Canton, Ohio. (528 Abington Ave., Zanesville, Ohio.)
Clemens, Eugene C., 204 Ceramics Bldg., Urbana, Ill. (108 E. Daniel St., Champaign, Ill.)
Dufour, Georges, 15 Rue Porchet, Haiphong, Tonkin, French Indo-China. (54 Rue Ducret, Aniche, Nord, France.)
Ekstrand, E. W., Whittier Terra Cotta Works, Painter and Barton Roads, Whittier, Calif. (Vitrefrax Co., Los Angeles, Calif.)
Feichter, Harold R., P. O. Box 66, East Sparta, Ohio. (2301 W. Maple Ave., Zanesville, Ohio.)
Ferguson, Chas. W., 19 St. Germaine St., St. Laurent, Quebec, Canada. (154 Macdonnell Ave., Toronto, Ont., Canada.)
Fernholtz, C. Walther, Box 708, Vernon, Calif. (Fernholtz Machinery Co., 2053 E. 38th St., Los Angeles, Calif.)
Fischer, Wilbur F., 168 N. Bridge St., Somerville, N. J.; Department Superintendent, Johns-Manville Corp., Manville, N. J. (70 Grove St.)
Hall, Herman A., 613 S. Pushing Ave., York, Pa. (Hotel Haynes.)
Hannah, E. R., 712 South Clark St., Mexico, Mo. (Madison, Ga.)
Kerr, Chas. H., 601 Cloverly Ave., Jenkintown, Pa. (114 Township Line Rd.)
Krak, J. B., Imperial Hotel, San José, Calif. (104 Rector St., Perth Amboy, N. J.)
Laughlin, Samuel O., Wheeling Tile Co., Wheeling, W. Va. (68 Franklin Ave., Saranac Lake, N. Y.)
Loomis, George A., 218 Thirteenth St. N. E., Mason City, Iowa. (465 Pine Street, Fontana, Calif.)
Loudon, William C., 1612 Rockford cor. Highland Drive, Dearborn, Mich. (2635 Norman Ave., Detroit, Mich.)
Lyttle, Frobisher T., 329 Adair Ave., Zanesville, Ohio; Laboratory Assistant, Mosaic Tile Co. (Abingdon Sanitary Mfg. Co., Abingdon, Ill.)
Metzner, O., 2631 Cleinview Ave., E. W. H., Cincinnati, Ohio. (Rookwood Pottery.)
Moncrieff, James W., 2904 Columbus Ave., Anderson, Ind. (780 Woodlawn Ave., East Liverpool, Ohio.)
Morimura, Yoshiyuki, 33 Minamimachi, Takanawa, Shibaku, Tokyo, Japan. (Kokura, Fukuokaken, Japan.)
Parker, Joseph W., Jr., 1606 W. 39th St., Kansas City, Mo. (1107 Oak St., South Pasadena, Calif.)
Plusch, John A., 4219 Hartell St., Holmesburg, Philadelphia, Pa. (402 Convers Ave., Zanesville, Ohio.)
Rossell, H. A., Christmas, Arizona. (Box 147, Deming, New Mexico.)
Sachs, John E., 205 E. Columbia St., Evansville, Ind. (1405 E. Columbia St.)
Schwetye, Fred H., 2015 Fair Ave., St. Louis, Mo. (4536 Clarence Ave.)
Sealey, P. T., 710 Broad St., Bloomfield, N. J. (3113 Southern Ave., Baltimore, Md.)
Spiker, John E., 1526 McCollum St., Los Angeles, Calif. (1347 Portia St.)
Thurlimann, Leo, 1437 Greenleaf Ave., Chicago, Ill. (15605 Myrtle Ave., Harvey, Ill.)
Türk, Karl, Porcelain Enamel & Mfg. Co., Eastern and Pemco Avenues, Baltimore, Md. (Eastern Ave. and 23rd St.)
Underwood, C. A., 113 Van Nostrand Ave., Englewood, N. J.; Babcock and Wilcox Co., 85 Liberty St., New York, N. Y. (145 Warren St., West Medford, Mass.)
Wagner, Bruce F., 3293 E. 146th St., Cleveland, Ohio. (Titanium Alloy Mfg. Co., Niagara Falls, N. Y.)
Wangland, Harry E., 4 St. George Apartments, Wellington St., London, Ont., Canada. (General Steel Wares Ltd., 5 Ardaven Place.)
Westendick, Frank C., Geological Department, Martin Bldg., Tallahassee, Florida; Assistant Geologist. (Massillon, Ohio.)
Yancey, Mary L., 207 Lynn Ave., Ames, Iowa; 217 Engineering Annex, Iowa State College, Ames, Iowa. (304 Russell Ave.)
Yeschek, Frank P., 4918 N. Hermitage Ave., Chicago, Ill. (2743 Sheffield Ave.)

Zimmermann, K., Rijkskleischool, Lange Tiendeweg 79, Gouda, Holland. (Membership transferred from Frederik Regout.)

STUDENT*

Alexander, H. Wilbur, 501 E. Springfield St., Champaign, Ill. (Auburn, Ill.)
Lane, Kenneth C., Box 102, Wellsville, N. Y. (Box 645, Alfred, N. Y.)
Schild, Ralph M., 201 Stanton Ave., Ames, Iowa. (2221 Donald St.)
Wheeler, D. D., 15 Bigelow St., Cambridge, Mass. (College of Mines, University of Washington, Seattle, Wash.)
Wormhoudt, G. H., Box P, Station A, Ames, Iowa. (1009 N. Main, Pella, Iowa.)

These roster changes which are published each month may be checked against the complete Membership Roster which was published in the July issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

LOCAL SECTION MEETINGS

Pittsburgh Meeting

The Pittsburgh Section will meet, Tuesday evening, Dec. 10 at 8 P.M. in the auditorium of the Bureau of Mines, 4700 Forbes St. W. C. Taylor, Chief Chemist, Corning Glass Works, will speak on "Glass Manufacturing Control." Officers for the coming year will be elected at this meeting.

OBITUARY

P. J. Ryan

An announcement has been received of the sudden death of Patrick J. Ryan, Woodbridge, N. J., on October 24, 1929. The October *Bulletin*, p. 325, contained a brief announcement of the death of Lawrence Ryan, younger brother of P. J. Ryan. Mr. Ryan was treasurer of the Mutton Hollow Fire Brick Co., Woodbridge, N. J., President of the Grace-Ryan Brick Co., and also of the Star Clay Products Co. Mr. Ryan was a member of this SOCIETY for many years.

NOTES AND NEWS

NEW JERSEY CLAY WORKERS' ASSOCIATION

The 1929 Fall Meeting of the New Jersey Clay Workers' Association was held at the Hotel Hildebrecht, Trenton, N. J., on October 24.

The morning session was opened at 10:30 with President J. A. Williams in the Chair. After an address of welcome by the president the following technical papers were read and discussed:

"Slip Room Control and Its Effect on the Finished Product," by F. W. Young, Filtration Engineers, Inc., Newark, N. J.
"New Metals for Die Construction," by Arthur W. F. Green, Poldi Steel Corporation of America, New York City.
Discussion of New Methods of Drying, led by C. F. Geiger, Carborundum Company, Perth Amboy, N. J.

The afternoon session was devoted to the reading and discussion of the following papers:

"Acoustic Properties of Ceramic Materials," by R. V. Parsons, Johns-Manville Corporation, New York City.
"New Developments in the Field of Pebble-Mill Grinding," by H. F. Kleinfeldt, Abbé Engineering Co., New York City.

"Chromium Plating of Dies," by Edward Smith, United Chromium Corp., New York City.

At the morning session a history of the life of the late Councillor of the Association, Charles A. Bloomfield, was read by F. A. Whitaker, and the members joined in a moment of silent prayer.

About 110 members were in attendance at the meeting. A "get-together dinner" was held in the evening at the Trenton Country Club and the entertainment committee, under the direction of J. A. Williams, had provided some decidedly unique features.

The next meeting of the Association will be held at the Ceramics Building, Rutgers University, New Brunswick, N. J., in December.

NEWS FROM THE CERAMIC SCHOOLS

Georgia School of Technology

The Ceramic Department of the Georgia School of Technology is entering its sixth year under conditions of greater stability. The formative and organization period is past and the Department is bending its efforts to be of service to the industry and also to assist in the development of the ceramic resources of the South.

The faculty, for the present year, remains unchanged with A. V. Henry, Professor and Head of the Department, W. H. Vaughan, Associate Professor, J. P. Breen, Instructor, and L. A. Tedder, Mechanician. The total student enrollment is thirty.

The Department is continuing its coöperation with the Geological Survey of Georgia, the railways, and power companies. Recently the Survey issued *Bulletin* No. 44, entitled "Sedimentary Kaolins of Georgia," all of the laboratory tests involved being conducted in the Georgia School of Technology. The Department is now assisting the Survey in a study of the shales of Georgia. When completed this work will be as comprehensive as that on the sedimentary kaolins.

With the coöperation of the Ceramics Department, the Central of Georgia Railway is revising its Mineral Directory which gives the geology and description of many mineral deposits in the area which it serves. The power companies, too, are devoting considerable attention to the ceramic industrial development of the South. The Georgia Power Company has, in the past few months, issued two books giving the results of industrial surveys, one being concerned with general whiteware and the other with electrical porcelain. Assistance has been given in the gathering and compilaton of data for both of these surveys.

More than fifty samples of clays and shales have been tested by the department during the summer to determine their commercial possibilities.

University of Illinois Announces Short Course in Clay Working and Enameling[1]

The Department of Ceramic Engineering, University of Illinois, Urbana, Illinois, announces that plans are being formulated for holding its biennial Short Course in Clay Working and Enameling, during the period of January 20 to 31, inclusive.

This Short Course offers an opportunity for plant men to acquaint themselves with the principles underlying the manufacturing processes used in the industry. A common school education is sufficient as preparation. No fees will be required.

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[1] Announcements will be mailed to all those interested by writing to Prof. C. W. Parmelee, Department of Ceramic Engineering, Urbana, Illinois.

School of Mines and Metallurgy, University of Missouri

The fall term opened on September 9 with an enrollment in the Ceramic Department showing a 20% increase over last year. The total enrollment at this date is thirty-four.

Last year's graduates were Hugo Harrod, who is employed by the Harbison-Walker Refractories Co., at the Vandalia, Mo., plant, and Harlow Jones, who is employed by the General Abrasives Co., Philadelphia. E. J. Harvey will graduate in February of next year. Nine seniors are scheduled to graduate next June.

The dry-press research work of the N.B.M.A. is well under way. A large hydraulic dry press with a 20-inch mold box has been installed and is now in use. This large mold box will make it possible to study the formation of firebrick shapes 10 to 14 inches in thickness. This work will include building brick as well as fire brick. Some fifteen companies in these fields have contributed the money for the purchase of the press and are now regularly receiving progress reports on the work.

The changes in curricula include a course in Portland Cement, Lime, and Gypsum; moving the Refractories course from the junior to the senior year; and shortening the course in Engineering Design and Plant Layout.

Senior Research Work this year is on the following problems: (1) The Mechanical Weathering of Clay, (2) High Temperature Insulating Brick, (3) Cause of Crumbling of Fire Brick in the Drier, (4) High Temperature Cements, and (5) Various Phases of the Dry-Press Processes in Making Building and Fire Brick.

W. D. Keller, a senior student in the Department, has published an article in *Brick and Clay Record*, October 8, 1929, on "Determining Alumina Content in High Alumina Clays." The methods provide for an approximate estimation of the alumina content in the field without any laboratory tests.

Ohio State University
Department of Ceramic Art

The Ceramic Art Department is starting the year with an enrollment of eight students, of whom two are freshmen, three juniors, and three students from other departments taking elective courses.

Edgar Littlefield, a graduate of O. S. U. in ceramic engineering in 1929 has been appointed as laboratory assistant in the department. Mr. Littlefield is at present carrying on an investigation of low temperature colored glazes of a special type.

Leslie Moody, a junior in ceramic art, is also acting as student assistant in the care of the laboratory and workshops.

The juniors this quarter are making a general survey of ceramic products with particular emphasis on the design possibilities of each field and are attempting in their laboratory work to produce examples of products in several of these typical branches.

At the request of the Art Division of the AMERICAN CERAMIC SOCIETY, the director of the department, Arthur E. Baggs, has been authorized by the University to devote some time to the study of the tableware industry in connection with the survey of the ceramic field which is being attempted by the Art Division. The object of this study is to investigate the needs of the industry in regard to designers and sources of design material and to define more clearly the training, both general and specific which industrial art schools should attempt to give in order to prepare their graduates to be of greatest potential value to the industry.

Ceramic Engineering Department

The enrollment in the Ceramic Engineering Department at Ohio State University is as follows: second year, 37; third year, 32; and fourth year, 30.

Freshmen do not enroll in separate engineering departments. The freshman class this year is larger, however, than that of last year, which indicates that the second year class of next year will doubtless be slightly larger than that of this year.

There are also four postgraduate students, three registered for the degrees of Ph.D., and one for Master's degree.

The department has been assigned one new lecture and seminary room and has equipped three rooms for graduate research. A new laboratory for testing fired products has also been added to the equipment.

There are several new courses to be given this year: (1) lecture course on Theory of Drying, (2) lecture course on Ceramic Plant Engineering, (3) laboratory course on Refractories, (4) laboratory course on Heavy Clay Products, and (5) lecture and laboratory course on Glass Technology.

O. S. U. Student Branch of American Ceramic Society Meeting

The Student Branch of the AMERICAN CERAMIC SOCIETY held a meeting Tuesday, November 12th, at the offices of the AMERICAN CERAMIC SOCIETY, 2525 N. High Street. The following men were elected: Gilbert Soler, President; Glenn Bernard, Vice-President; Ralston Rusell, Secretary-Treasurer; Warren F. Copp, Representative to the Advisory Board of the Ohio State Engineer; and Glenn A. Hutt, Corresponding Secretary. R. C. Purdy, General Secretary of the AMERICAN CERAMIC SOCIETY and George A. Bole, President of the AMERICAN CERAMIC SOCIETY were speakers.

Four students, Arthur Drake, Walter Hayes, Stanley Leaver, and Milton Waldschmidt, have been honored with membership in Keramos, honorary ceramic engineering fraternity. Election into this Society is based on four points: scholarship, leadership, technical ability, and personality.

Honorary memberships were awarded to R. M. King, Assistant Professor of Ceramic Engineering and George A. Bole, Research Professor, also President of the AMERICAN CERAMIC SOCIETY and General Secretary of the Ohio Ceramic Industries Association.

For this year's work the Society has chosen an investigation of the leading feldspars of this country. A. S. Watts of the Department of Ceramic Engineering, an authority on feldspar, will be the advisor in this program of study.

Pennsylvania State College

The Department of Ceramics at Penn State has started the year in temporary quarters in the Old Mining Building. The laboratory and offices formerly used have been dismantled, making way for a new power house now under construction. The School of Mineral Industries has under construction a new building in which the Department of Ceramics will have much enlarged laboratory facilities and the program in process of preparation for that building includes a very much extended program of research and service to the industries. It is also expected, of course, that the number of students will increase gradually. A certain amount of extension work in ceramics is being planned.

The personnel of the Department is the same as last year, J. B. Shaw, Head of the Department, and George J. Bair, Instructor in Ceramics. No new courses have been added. At the present time a great deal of research is being done in connection with Committee C-8 on Refractories, developing an abrasion test; also work on utilization

of local refractory clays; work on standardization of high temperature tests in coöperation with the Sub-Committee of Committee C-8. The development of a new process of producing heavy structural materials is one of the problems being carried out by a graduate student.

The student body consists of twenty-five undergraduates made up as follows: freshmen 9, sophomores 6, juniors 4, and seniors 6. There are two graduate students, both of whom will obtain their Master's degrees at the end of this year.

The Student Section of the AMERICAN CERAMIC SOCIETY has been organized electing Nicholas H. Snyder, President; Joseph D. Custer, Vice-President; and James H. Ammerman, Secretary-Treasurer. It is planned to hold monthly dinner meetings following the custom of the last three years, which has been successful. Speeches were delivered at these meetings by students, faculty, and visitors, and programs of this nature will be continued this year.

Priestley Lecture Announcement

The School of Chemistry and Physics in coöperation with the Ceramics Department of the School of Mines and Metallurgy of Pennsylvania State College, announces the fourth annual Priestley Lectures to be given by Lewis Navias, research ceramist of the General Electric Co. These lectures will be held the evenings of December 16, 17, 18, 19, and 20 in the Chemistry Amphitheatre, State College, Pennsylvania. The five lectures will be grouped about the general topic "The Relation of Physical Chemistry to Ceramics."

The individual lectures will deal with the following specific topics:

(1) A survey of the field of ceramics showing by numerous examples the dependence of ceramics upon physico-chemical principles.
(2) The vitreous state of glasses, glazes, and enamels.
(3) The properties of some important natural materials such as silica minerals, clays, and feldspars.
(4) Porcelain and similar bodies.
(5) Shaping refractory oxides. The artificial production of sapphires.

University of Washington

The enrollment this year consists of four freshmen, three sophomores, three juniors, two seniors, two graduate students, and six specials, a total of twenty students. No changes have been made in the teaching personnel or curriculum.

Two graduate students are engaged in nonmetallic research work in coöperation with the Northwest Station, U. S. Bureau of Mines. C. E. Curtis is engaged in studying the dewatering of clay and ocher suspensions by electrophoresis or electrical filter pressing. He will likewise study the dewatering process by the use of a spray evaporator. Wurth Kriegel is studying the general problem of flotation in connection with clays and ochers. Besides a homemade washing apparatus he has a new Dorr bowl classifier and settler in inclosed circuit with a large pebble mill. These two graduate students have been working on their problems all summer. Jack Cunliffe is starting the study of the resistance of various refractories to waste sulphite liquors from the pulp and paper mills. These strong alkaline materials have been very destructive to most all types of refractory materials.

A get-together "tea" was held one evening of the first week in school to talk over the summer's experiences. These varied from a description of a ramble through Europe

by Neal Fosseen to an account by Fred Kettenring of a rescue party on the icy slopes of Mt. Baker, the white-capped old volcanic cone in the northern Cascade Mountains.

A. L. Miller of the Department of Civil Engineering is now completing the tests of brick and tile from practically all of the clay product companies of Washington, Idaho, and Oregon. This is the first year's work of the new Clay Products Coöperative Research, sponsored by the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY for the purpose of improving the quality and usefulness of the clay products of the Pacific Northwest.

Hewitt Wilson head of the Department of Ceramic Engineering was employed during the summer as nonmetallic engineer for the U. S. Bureau of Mines to study the ocher and mineral pigments of the United States. Color, oil absorption, and strength tests were made on several hundred samples which were collected in eighteen different states. This is the first time a national report has been prepared on this subject and it reveals a large number of useful pigments which have not been used heretofore.

University of Toronto

The ceramic students registering this fall at the University of Toronto are as follows:

4th year:	J. M. Higgins
	F. R. Stone
3rd year:	James S. Little
	E. R. Davey

H. L. Watts qualified for the fourth year but expects to spend one year in industrial work before returning for his senior year. He is with the National Sewer Pipe Co.

Industrial experience was obtained by all the undergraduate students during the summer and the three men finishing the course last spring are making good in their new positions.

A series of fire brick was made of Northern Ontario fire clay and is being tested at the University of Toronto. Mr. Dyer, geologist for the Ontario Department of Mines, obtained the clay in the field and Messrs. Smith and Stone of Georgetown made and fired the brick.

The field work of the survey of ceramic plants of Ontario has been completed by Professor R. J. Montgomery of the University and a report will be written during the coming winter. The Ontario Department of Mines is having this survey made at the request of the Canadian National Clay Products Association.

Virginia Polytechnic Institute

The ceramic curriculum at Virginia Polytechnic Institute is being carried on in conjunction with the Mining Engineering Department. This plan will be continued until the clay survey of the state and the proposed work with the manufacturers of the state is completed.

The laboratory is well equipped for this testing work and plans are made to install further equipment so that a four-year curriculum in Ceramic Engineering and also in Ceramic Technology may be intended.

Iowa State College

Dr. Cunningham, the new member of the faculty, and a specialist in colloid problems, is working on colloid problems in clays. He has also introduced a new course of ceramic study in eutectics for senior ceramic engineering students at Iowa State College.

The remodeling of the Ceramic department is rapidly nearing completion. The new wing already constructed and the entire remodeling of the old quarters will give Iowa State College one of the best-equipped departments in the country. The new laboratories will allow for more extensive work in student research on ceramic problems. Professor Cox, head of the department, is planning to alter the course of study for ceramic students. The new quarters give a much larger capacity and Professor Cox is planning on using this by giving the ceramic students more work in their own department.

THE JOSIAH WEDGWOOD BICENTENARY[1]

Further Arrangements for a Magnificent Program. Pageant Libretto by Mr. Rudyard Kipling?

Interest in the Josiah Wedgwood Bicentenary celebrations, which will take place in May next year, is growing week by week in North Staffordshire, and from the support that the program has already received, it is certain that the event will be one of the most memorable in the history of the district.

It is hoped that the Prince of Wales will attend the celebrations, and the Queen has already consented to be patroness of the Historical Exhibition, and has graciously offered to loan examples of Wedgwood ware from the private collection at Windsor Castle. The Archbishop of Canterbury, and probably the Archbishop of York, will take part in the religious services.

A great pageant is being organized in which 5000 or 6000 people will take part, and which will deal with episodes in the life of the district from the days of the Romans down to present times. Mr. Rudyard Kipling is being approached with reference to the writing of the libretto.

The program will include in addition to the pageant and historical exhibition, an exhibition of pottery never before equaled, a military tattoo and other events of outstanding interest.

Excellent progress is being made with the organization of this magnificent event. The general committee has coöpted the services of all who are willing to help in the organization, and generous support has been promised to a guarantee fund. There is every prospect that the various sections of the program will be a financial success, and that a sum will be available for distribution among charities.

Officials Appointed

Mr. T. B. Roberts was appointed Hon. Treasurer and Mr. J. W. Cooper Hon. Secretary, while the appointment of Mr. Baring, of Cheltenham, as Organizing Secretary, was also approved. Sir Francis Joseph said that Mr. Baring had been associated with the principal pageants in all parts of the country.

They were going to do something never before carried out in the City, said Sir Francis. He had been tremendously encouraged by the response that had been made by the business men who were attending the meetings of the general committee in ever increasing numbers. They realized that if they made a success of the event they would be doing what Mr. Arnold Bennett had said in his tribute to Josiah Wedgwood—"putting Stoke definitely on the map." They were going to make it something more than a blot; they were going to make it the biggest thing on the map, if they could.

Pageant Episodes

Reports on the work of the various committees were presented. The historical pageant, which will probably take place in one of the parks will be on a most ambitious scale. It is suggested, from details submitted by Mr. T. Pape, that there shall be nine episodes, as follows:

A Roman episode centered round the Roman road which passed through North Staffordshire.

An ecclesiastical episode, bringing in the Mercian history of the 7th and 8th Centuries, centered round Stoke.

An episode in connection with the Manorial Court of Newcastle-under-Lynne and John O'Gaunt.

[1] From North Staffordshire press notice.

An episode in connection with the dissolution of Hulton Abbey.
An episode illustrating the life of the early potters and the beginning of coal mining (Toft and Elers).
An episode based on the retreat after the Jacobite Rebellion of 1745–46.
A Wedgwood episode introducing Bentley, Whieldon, and Brindley.
An episode showing the development of the potting industry.
Grand Finale.

The Pageant Committee has asked Mr. Gordon M. Forsyth (Superintendent of Art Instruction in Stoke-on-Trent) to be Master of Design; Dr. Challinor, of Normacot, Longton, to be Master of Music; Mr. R. J. Carter (Chief Constable of Stoke-on-Trent) to be Master of Horse; and Mr. H. Goldstraw, architect; Tunstall, to be Master of Grand Stand.

Various sub-committees have been formed and associations in the district are invited to send representatives.

Pottery Exhibition

Mr. Ashley Myott dealt with the work of the committee arranging the Pottery Exhibition and said that practically all the best-known manufacturers in the Staffordshire potteries were included in the list of exhibitors, and they were very sanguine that they would be able to stage an exhibition of pottery, the equal of which had not been seen in England before, or in the world.

A nominal charge of 6d. admission had been decided on, but they did not want to deprive anyone of the opportunity of attending the exhibition, and they proposed that Saturday should be a free day. The exhibition would include a demonstration of a potter's wheel, and the committee would discuss a suggestion (made by Sir Francis Joseph) that a film on the pottery industry should be shown.

The Queen's Help

Ald. Miss Farmer said that the Committee dealing with the arrangements for the historical exhibition had decided that no charge could be made for admission to this section, which would be held in the Hanley Museum. They had received many promises of exhibits.

Mr. Maxwell (Curator) gave the following list of promised loans:

Her Majesty the Queen.—Objects to be selected from Windsor Castle.

Sir Cecil Harcourt Smith, C.V.O.—Wedgwood ware.

Lady Lever Art Gallery.—Equestrian portrait on pottery slab of Josiah Wedgwood, by George Stubbs. Ten important pieces of pottery, including a Font. Sword and other objects with cameo mountings.

Mr. Harvey Vaughan Williams.—Portraits of Josiah Wedgwood and his wife, by Sir Joshua Reynolds.

J. Wedgwood and Sons, Ltd.—Objects from Etruria Museum, including documents and maps.

P. and D. Colnaghi and Co.—Drawing (modern) "Wedgwood's Works," by Job Nixon.

The Earl of Dartmouth.—Etruscan ware from Patshull.

The Earl of Harrowby.—Wedgwood ware.

Prof. Jocelyn Thorpe.—Terra cotta portrait in relief, of Mrs. Wedgwood.

Sir Francis Joseph said that Col. Clive had informed him that there was every prospect of a very effective and attractive show for the military tattoo.

Finance

On the subject of finances Ald. F. Hayward said that if there was a substantial income from the Pageant it would reduce the call to be made on the guarantee fund, and they might have a balance to disburse among charities.

The work of the Transport Committee was reported on by Mr. Bingham, who referred to the cheap fares and facilities which would be offered to bring people to the great festival.

Publicity Schemes

On the publicity side, Sir Francis Joseph said he had been in communication with Mr. Gordon Forsyth. They wanted a poster for boardings and a design for the official program, and Mr. Forsyth suggested that payment for the former should be a prize of £50, and for the program a prize of £5.

Sir Francis Joseph said the poster design might be reduced to postcard size, and

further publicity gained in this way. He would approach the Postmaster of Stoke-on-Trent with regard to the use of obliberating stamps advertising the celebrations.

Prebendary Crick spoke on the religious side of the celebrations. The Archbishop of Canterbury is attending a service on Sunday, May 15, for the opening of the celebrations, he said, and it was proposed that a combined service in the evening should be broadcast by the B.B.C.

Other items were discussed, including a suggestion by Mr. G. H. Barber, of advertising the celebrations on the screen.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for the Advancement of Science	Dec. 27–Jan. 2, 1930	Des Moines, Iowa
AMERICAN CERAMIC SOCIETY	February 16–22, 1930	Toronto, Canada
(Pittsburgh Section)	December 10	Pittsburgh, Pa.
American Chemical Society	Week of April 7, 1930	Atlanta, Ga.
American Electrochemical Society	May 29–31, 1930	St. Louis, Mo.
American Foundrymen's Assn.	May 12–17, 1930	Cleveland, Ohio
American Institute of Chemical Engineers	December 2–4	Asheville, N. C.
American Institute of Mining and Metallurgical Engineers	February 17–20, 1930	New York, N. Y.
American Society of Mechanical Engineers	December 2–6	New York, N. Y.
American Society for Testing Materials	June 24–28, 1930	Atlantic City, N. J.
Assn. of Scientific Apparatus Makers of U. S.	May, 1930	Atlantic City, N. J.
Common Brick Manufacturers Assn. of America	February 3–8, 1930	Memphis, Tenn.
International Heating and Ventilating Exposition	January 27–31, 1930	Philadelphia, Pa.
Manufacturing Chemists' Assn. of the U. S.	May, 1930	New York, N. Y.
National Academy of Sciences	April 28–30, 1930	Washington, D. C.
National Assn. of Manufacturers of Heating and Cooking Appliances	May, 1930	New York, N. Y.
National Exposition of Power and Mechanical Engineering (Eighth)	December 2–7	New York, N. Y.
National Glass Distributors Assn.	December 3–5	Pittsburgh, Pa.
National Paving Brick Manufacturers Assn.	December 4–7	Chicago, Ill.
New Jersey Clay Workers Assn.	December, 1929	New Brunswick, N. J.
Sand-Lime Brick Assn.	February 4–6, 1930	New York, N. Y.
Structural Clay Tile Assn.	February 12–14, 1930	Columbus, Ohio
Taylor Society	December 4–6	New York, N. Y.
Tile and Mantel Contractors' Assn.	April 8–12, 1930	New Orleans, La.

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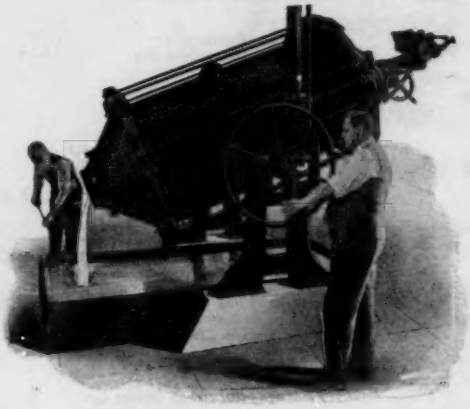

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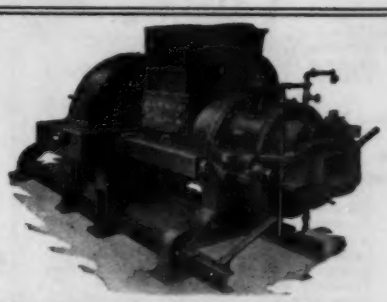

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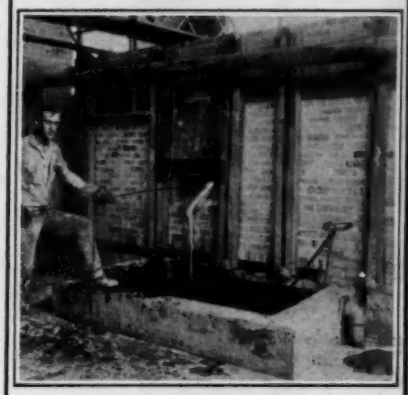

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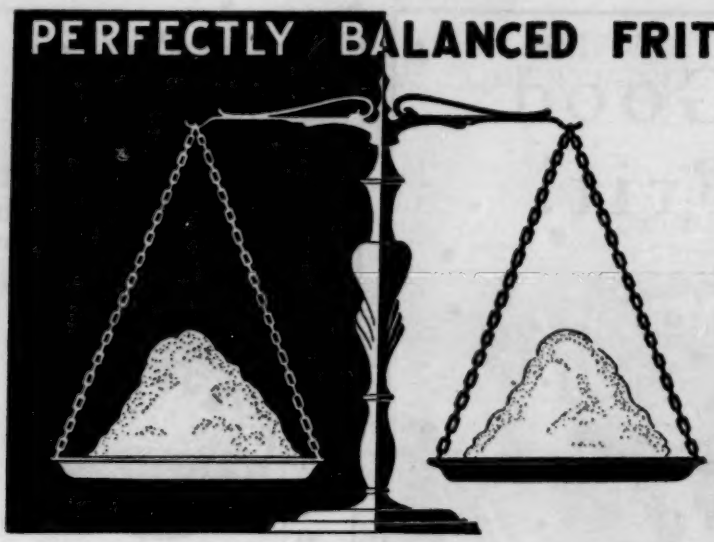

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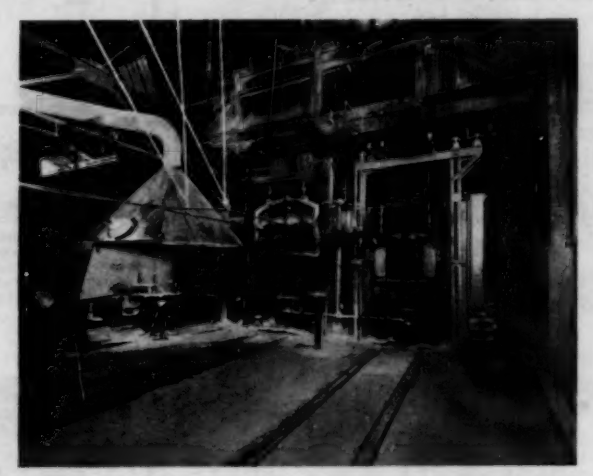

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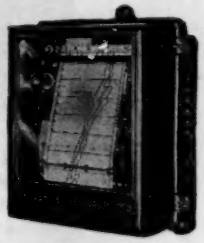

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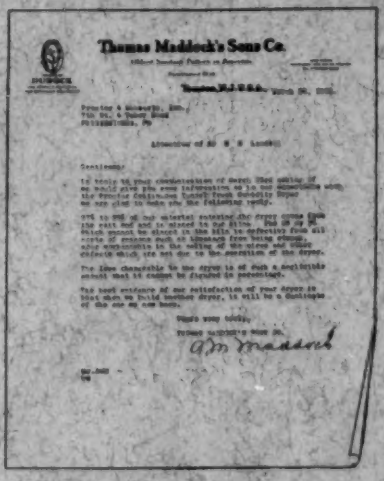

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